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EDITORIAL COMMENT

B.B.C. Succession

Probability of No Appointment

SIR JOHN REITH has said farewell to the British Broadcasting Corporation, and whether or not his vacant chair is reoccupied by the time these comments appear does not alter the fact that the delay in deciding upon the succession is regrettable from many points of view.

We would have expected that the new appointment would have been made at the time that Sir John Reith's acceptance of his new post was announced.

It seems to us inconceivable that the departure of Reith to another office or some other eventuality which would have deprived the B.B.C of his services should not have been provided for in advance and that at least Reith himself should have had the right to recommend, if not actually to appoint, a candidate of his own choice.

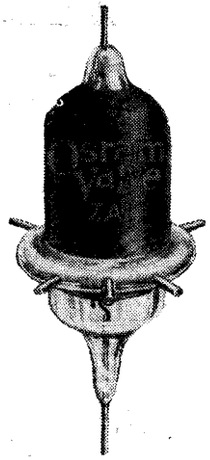
If no provision has been made to take over the reins from Sir John Reith then the only possible explanation seems to be that in an otherwise highly organised scheme a serious lapse has occurred.

During the period since the announcement of Sir John's departure rumour has appointed a series of persons to the post and we can picture the position which must exist at Broadcasting House with so many presumptive chiefs, each having his group of supporters. This division of the B.B.C. into camps can hardly fail to make the task of any man who eventually had to take over a far more difficult one than would have been the case if an early appointment had been made, leaving no time for speculation. Almost, it would seem to us, the delay must mean that the appointment will not fall to an individual within the existing organisation.

It is difficult to speculate on how matters will work out, especially as the official answer may be made known at any time. Yet we would venture the suggestion that there may quite likely be no successor appointed to replace the irreplaceable Sir John Reith. Reith has for some years now tended to favour the appointment of controllers responsible for the various branches of B.B.C. activities. These appointments have relieved the chief of a great deal of detail and appear to have been a satisfactory way of apportioning both the work and the responsibility. A slight extension of this plan, increasing the responsibility of individual controllers still further and perhaps with the appointment of additional controllers if the need should arise, would be a solution which would do honour to Reith as a confirmation of a policy introduced by him and at the same time it would make the position of the Board of Governors, and especially of the Chairman of the Board, more effective. The Chairman of the Board would then become the spokesman and head of the Corporation, and his should certainly become a whole-time appointment.

Reith, we should remember, was head of the B.B.C. before the idea of a Board of Governors was propounded, and it was in order not to divest him of status when a Board was appointed that the post of Director-General was created. We believe that if Sir John Reith had not been already in "possession," so to speak, the Chairman and Board of Governors would have ruled over the B.B.C. without such an appointment being made at all.

Is it not logical, therefore, to suggest that a proper solution of the matter could now be found by confirming Reith's organisation in the matter of controllers and at the same time strengthening the position of the Board of Governors ?



The Acorn Valve

ITS ADVANTAGES AND METHODS OF OPERATION AT ULTRA-HIGH FREQUENCIES

THE various applications of the miniature Acorn valves, which have been designed especially for use on the ultra-high frequencies, and the circuits found most suitable for them, are discussed in this article by a member of the Technical Staff of the M.O. Valve Co.

AT frequencies above 50 Mc/s it has been found that the amplification obtainable from normal receiving type valves decreases rapidly, which is due in part to the time of flight of the electrons from the cathode to the various other electrodes being comparable to one cycle of the frequency of operation and in part to the high self-capacity and inductance of the valves.

The only satisfactory method of obtaining a reasonable stage gain at frequencies between 50 and 300 Mc/s is by means of the Acorn valve.

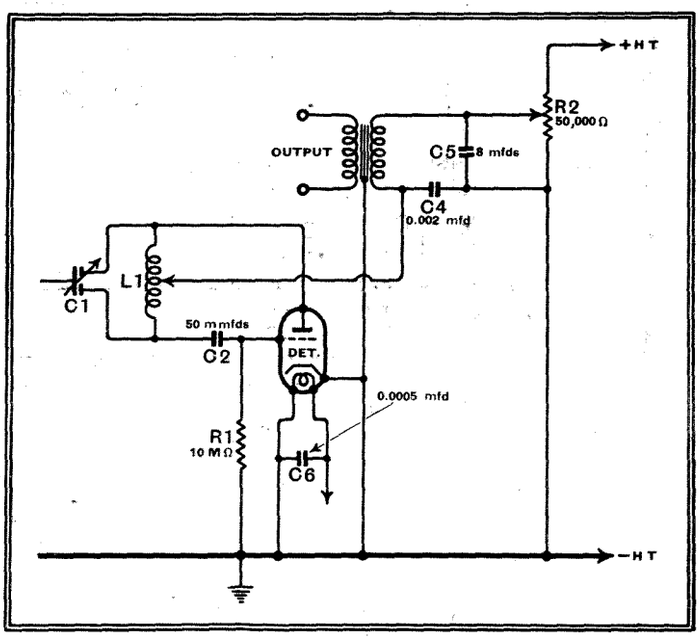


Fig. 1.—Circuit for an Acorn triode used as an ultra-short-wave regenerative grid detector.

These valves, which are now available both as triodes and as screen pentodes, have such a small physical size that their inter-electrode capacities are very low. Their small physical size also reduces the time of flight (electron transit time) until it is no longer troublesome, and the short leads to the elements permit the inductance of the circuit to be concentrated mainly in the tuning coil.

In Table 1 the respective capacities of a mains triode, the Marconi or Osram, H42, and the Acorn triode of this make are given for comparison purposes. It is interesting to note that the output, or anode-cathode capacity, of the Acorn is relatively very much smaller than the other capacities.

TABLE 1.

Comparison of Valve Capacities.

	H42	HA1
Grid-anode	3.0	1.4
Grid-cathode	2.6	1.0
Anode-cathode	5.3	0.6

The triode valve will be considered first as it is the simpler type, and, being cheaper, is more likely to be popular at the present time. Its first and most obvious use is as a regenerative grid detector, to which super-regeneration may be added if desired. The circuit recommended is shown in Fig. 1, which as will be seen is similar to the well-known Hartley oscillator circuit, but regeneration is controlled by varying the anode voltage by means of the resistance R2. Increasing the anode voltage beyond the oscillation point causes super-regeneration to start, the frequency of which is partly determined by the grid leak and condenser R1, C2. This gives a smooth control and does not disturb the tuning of the circuit.

The size of the coils and number of turns required for various wavelengths are given in Table 2. The tapping on the coils should be near the centre, but the position for best operation will have to be found by experiment, since at very high frequencies the layout of the components, wiring, etc., greatly influence the operation of the circuit.

A tuning condenser having a very low inductance is essential at the ultra-high frequencies, and the one used in the original experiments with the valves was made as shown in Fig. 2. Its construction provides a convenient way of mounting the coil.

It is a differential-type condenser, and connection is made to the two fixed vanes only, the rotor merely serving to vary the capacity. As no connection is made to the rotor, perfectly silent operation is ensured. In this condenser the rotor plates are semi-circular and have a radius of ⅝in., which dimension will give a good indication of the size of the other parts required.

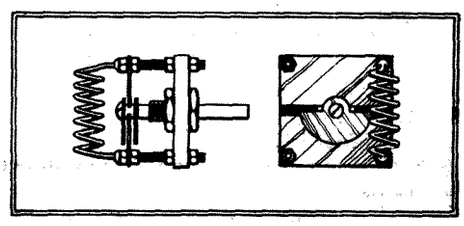


Fig. 2.—Details of split-stator condenser recommended for ultra-short-wave sets and showing also method of mounting the coil.

This condenser was used for the very high frequencies, but at 60 Mc/s or so more plates, or even a larger condenser of standard pattern, can be employed. The use of the smallest capacity to tune over the waveband to be covered is most desirable, as it enables the largest possible inductance to be employed.

Receiver Assembly

The mechanical layout of this circuit is very important, and the components must be arranged so that short leads can be made. The Acorn valve lends itself very well to this, due to the manner in which the leads come out from the side of the glass pinch.

A two-valve circuit employing a separate quenching valve, which gives a higher efficiency than the self-quenching circuit of Fig. 1, is shown in Fig. 3. The quenching valve does not need to be an Acorn, and a valve of the MHL4 class can be used. The coils L2, L3 are a standard quench oscillator unit.

The HA1 valve may be used as an

TABLE 2

Ultra HF coils for use with HA1 and ZA1 valves.

1 metre ...	5 turns	¼in. diameter : turns spaced to occupy 1in.
2 metres ...	9 turns	¼in. diameter : turns spaced to occupy 1⅛in.
3 metres ...	5 turns	½in. diameter : turns spaced to occupy ¾in.
5 metres ...	13 turns	½in. diameter : turns spaced to occupy 1⅜in.

All coils are wound with 16 S.W.G. copper wire and the tuning condenser is that shown in Fig. 2.

oscillator, using the circuit shown in Fig. 4. Used in conjunction with an Acorn pentode, the ZA1, an ultra-high frequency superheterodyne, can be built. The coil L4 can be similar to those given in Table 2, though in the interests of frequency stability 30 per cent. fewer turns should be used, together with a larger condenser, which need not be of the special type previously described. Further details of the ultra-high-frequency receiver will be given when the Acorn pentode is discussed. The cathode tap should include one-quarter to one-half the total number of turns.

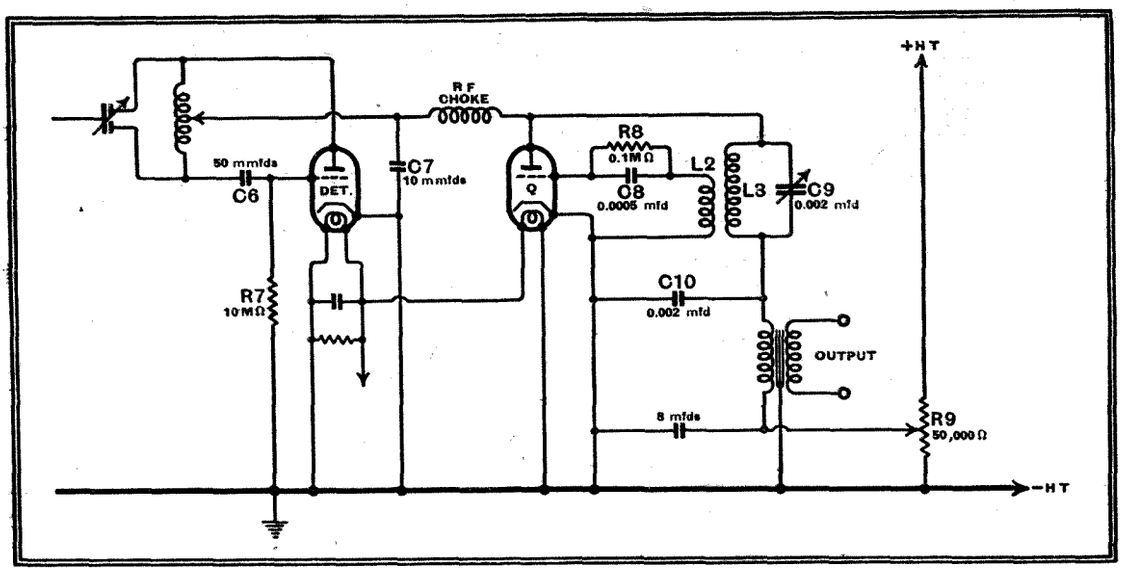


Fig. 3.—Super-regenerative circuit using an Acorn triode for the detector valve.

The Acorn triode is particularly suitable for use as an anode bend detector for valve voltmeter use, and, due to its high input impedance and small physical size, very little extra loading is put on the circuit at frequencies up to 20 Mc/s. A suitable circuit is given in Fig. 5. The resistance R12 biases the cathode to a voltage E + 1 volts, when E is the peak value of the input to the grid. When working at frequencies above 5 Mc/s, the mica condensers C13 and C15 are necessary, in addition to the larger paper condensers C14 and C16. It is suggested that the valve and mica condensers be mounted in a small shielding can with a flexible lead to the meter and batteries, so that the valve may be placed close to the circuit to be measured.

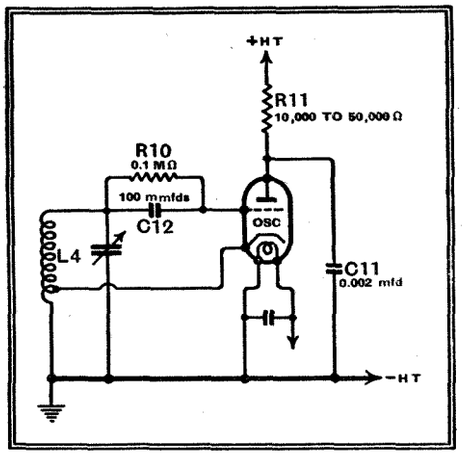


Fig. 4.—Typical oscillator circuit using an Acorn triode valve.

Fig. 6 shows a suitable circuit for a low-powered transmitter. Coils similar to those previously described may be used up to 150 Mc/s, but at higher frequencies the use of parallel or concentric tubes (Fig. 7) is recommended, as much higher efficiency and greater frequency stability is thereby obtained. The position of the tap on coil L5 in Fig. 6 should be varied to produce the greatest output. A small transmitter made with the circuit of Fig. 7 gave good results at 300 Mc/s—i.e., one metre. It is built on a copper chassis which serves as a support for the lines; the anode line is earthed by the condenser shown, which is formed by interposing a piece of mica between the chassis and the copper support for the line. The length of each parallel line should be about 4in., and final tuning is done by the condenser C20. The aerial for local work may be a short vertical rod. Even higher efficiencies and greater frequency stability may be obtained by the use of concentric lines, each line being about ¼ wavelength long, and the ratio between the diameters of the outer and inner conductors being three or four to one.

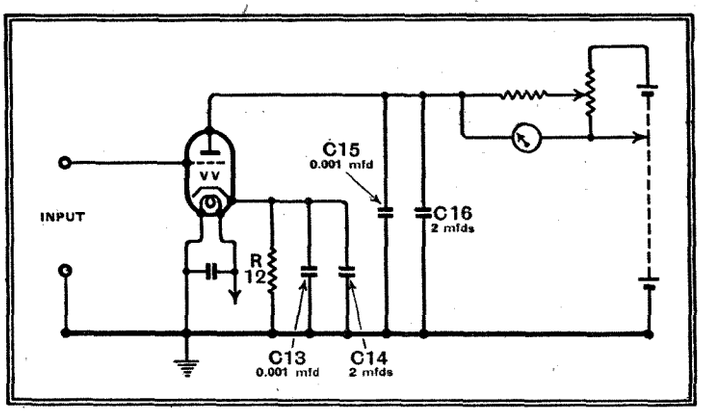


Fig. 5.—Using this circuit an Acorn triode can be employed as a valve voltmeter.

The Acorn pentode is a development of the triode; it enables real RF amplification to be obtained at frequencies above 50 Mc/s, where the normal receiving valve is likely to act more as an attenuator than as an amplifier. In appearance the pentode ZA1 is similar to the triode already described, but the anode and control grid connections are brought out at opposite ends of the glass bulb. This allows the valve to be mounted on a metal screen with the grid and anode circuits completely shielded from each other; the connections brought out through the glass pinch should all be maintained, as far as RF is concerned, at earth potential when the valve is acting as an amplifier. A special type of mounting enables this to be done. The by-pass condensers, which are almost a part of the valve holder, form a very low inductance path from screen to cathode. Where other capacities are required, such as

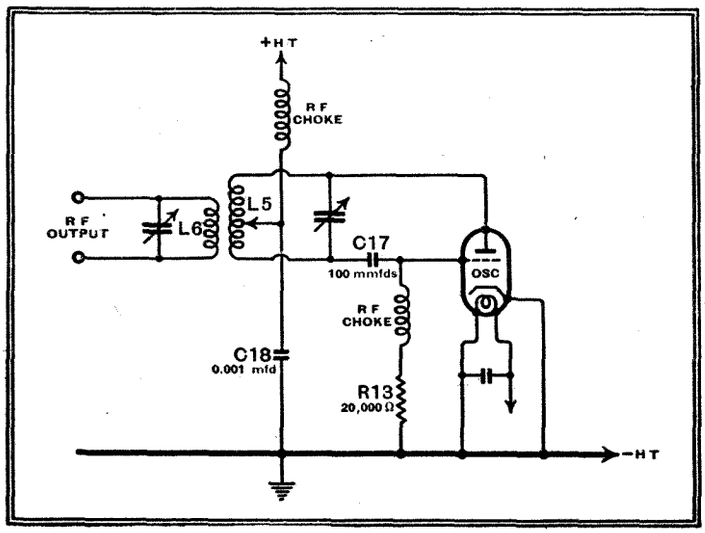
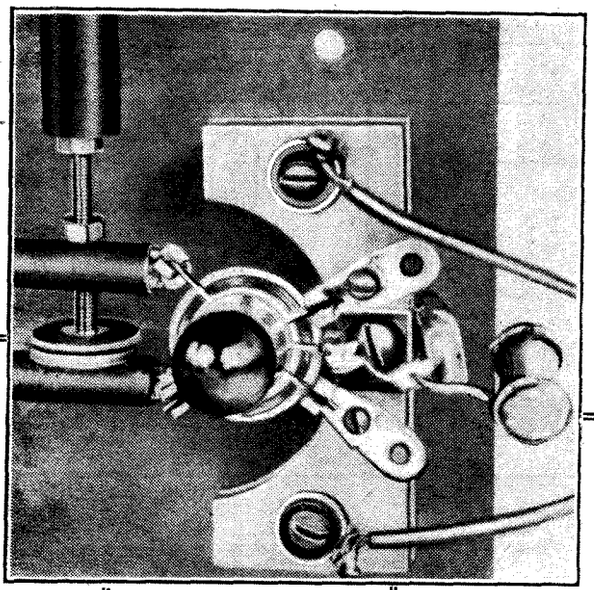


Fig. 6.—Circuit for a low-power ultra-short-wave transmitter.

across the cathode bias resistance, further copper and mica discs can be added. At the lower frequencies, between 25 and 50 Mc/s, where the Acorn valve has still an advantage over the normal pentode, this special type of holder is unnecessary, and small mica condensers mounted close to the valve give satisfactory results.



Method adopted for mounting the valve in the "long-lines" transmitter of Fig. 7. The disc-type variable condenser is C20 while on the right of the valve-holder are C19 and R14.

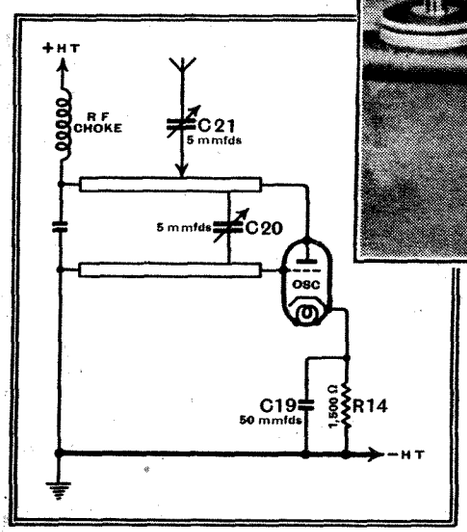


Fig. 7.—Good frequency stability at the very high frequencies can be obtained with this circuit used as a transmitter.

At still lower frequencies, apart from the small physical size, the Acorn has little advantage over the ordinary type of valve.

Fig. 8 shows a suitable circuit which is similar to that used at the lower frequencies, apart from some of the component values. The ZA1 valve is coupled to a super-regenerative detector similar to that shown in Fig. 1, with considerable improvement in selectivity and reduction in radiation from the oscillating detector. The coils L7 and L9 should be similar to those described in Table 2, but due to the larger condensers needed to give a wider tuning range, about 30 per cent. fewer turns should be used. The aerial coil L8 should have about 6 turns of 16 SWG wire wound to ½in. diameter.

Many other types of super-regenerative circuits using these valves could be devised. Suppressor injection of the interruption or "quench" frequency can be employed, and this method of operation would seem to have several advantages. Independent control of the various voltages is available with this scheme, and although little practical work has been done with this particular arrangement, it is one that is well worth further investigation.

As a frequency changer valve in conjunction with a separate oscillator the ZA1 will give good results, using the circuit shown in Fig. 9. To increase the stage gain, regeneration is produced by tapping the cathode into the grid coil, and it is controlled by variation of the screen voltage. If regeneration is not required, the ZA1 cathode may be returned to earth, and a further ZA1, using part of the circuit of Fig. 8, used as an RF amplifier. As before, the coils used for 50-60 Mc/s work should consist of about 8 to 10 turns of ½in. diameter, the exact frequency coverage being obtained by altering the spacing of the turns—i.e., pulling the turns apart reduces the inductance and vice versa. It should be remembered that the usual amplifier using an IF of 460 kc/s is hardly suitable for use in an ultra-high-frequency superheterodyne; frequency instability of the transmitter and receiver will be emphasised, and satisfactory reception will be impossible. A high IF of 5 megacycles, having a band width of, say, 50 kc/s, will obviate this and at the same time enable high fidelity broadcast programmes on the ultra-high frequencies to be received.

Acorn valves are, of course, not required in the IF amplifier but only for the frequency-changer, local oscillator and RF stage if one is used.

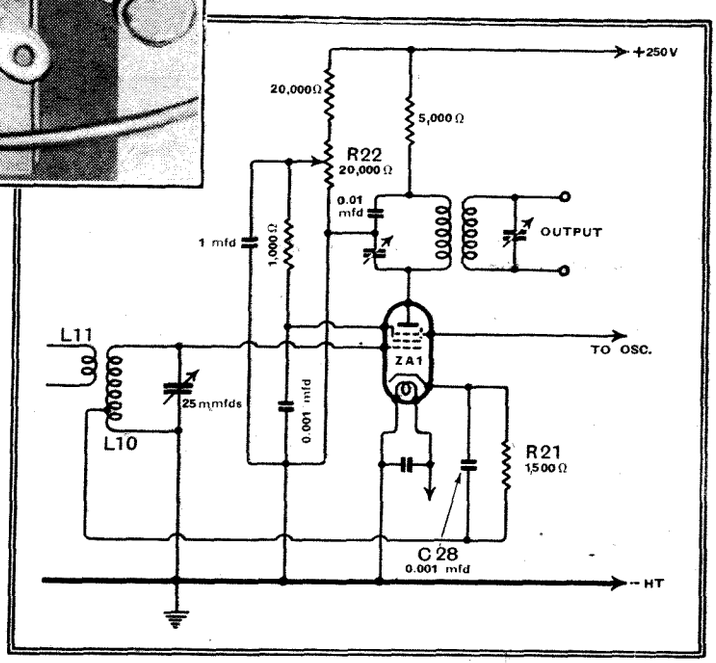


Fig. 9.—Frequency changer circuit for UHF reception using an Acorn pentode with RF regeneration and separate oscillator.

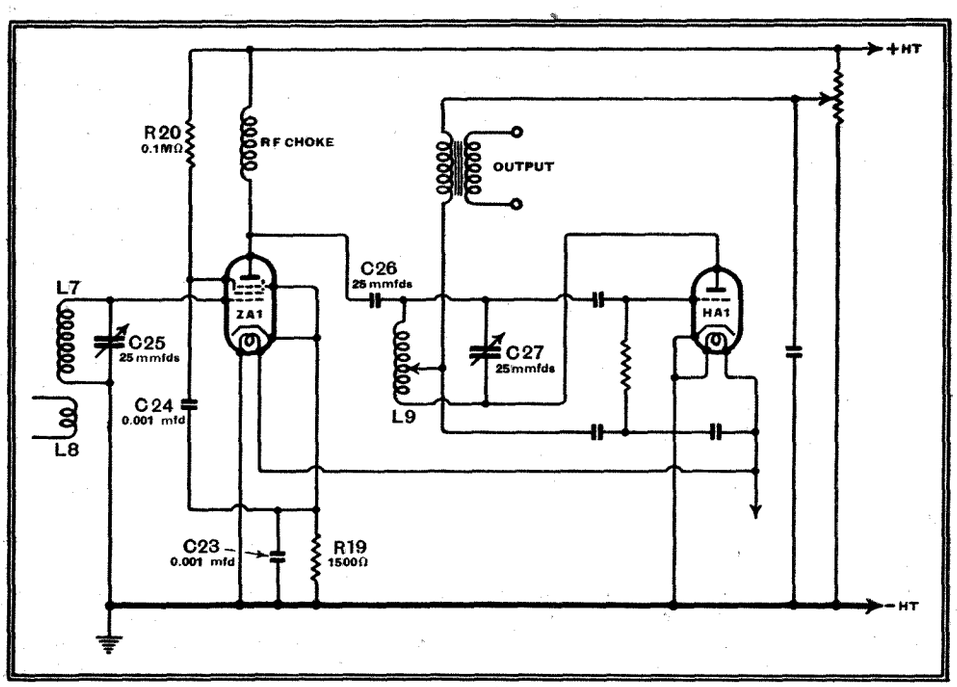


Fig. 8.—An Acorn pentode used as an RF amplifier followed by a triode of the same type arranged for ultra-short-wave reception.

More About Magnetic Tuning

SINGLE-KNOB CONTROL OF MULTI-CIRCUIT SETS

By L. de KRAMOLIN

IN our issues of February 24th and March 3rd, 1938, we described a system of tuning in which the inductance of a coil is changed by varying the permeability of its iron-dust core by means of an electro-magnet. The application of this system, which seems to offer interesting possibilities for remote control, is now considered in relation to multi-circuit receivers.

THE sensitivity and selectivity of the single-circuit receiver considered in previous articles can be improved by the provision of reaction applied through an additional winding on the RF core lying between the poles of the "tuning magnet." Adjustment of reaction from a distant control point can be carried out, as indicated in an earlier article, by varying either the grid bias, the anode voltage, or (when a multi-grid valve is used as a detector) the auxiliary grid voltage, by means of a potentiometer or other device. With such a receiver quite useful long-distance reception is possible under good conditions, but, naturally, for regular reception at considerable ranges a multi-circuit receiver is indispensable.

In constructing such a receiver the most straightforward thing to do is to give each circuit its full complement of tuning components, so that at the control point there will be as many adjustable resistances as there are circuits, each to be adjusted separately, like the condenser knobs on an old-fashioned TRF receiver. If the field currents for the various tuning magnets can thus be regulated individually the design of a multi-circuit receiver presents no special difficulties—at least as regards its remote control—compared with a single-circuit receiver.

If, however, single-knob tuning is to be effected by means of a more or less rigid mechanical coupling between the individual magnetic-field regulators, then the ganging troubles arise which are common to all such multiple arrangements. In the case of a multi-circuit "straight" receiver, for instance, all the circuits must be kept aligned to exactly the same wavelengths throughout the whole wave-range, while in a superhet receiver the connection between the various tuning elements must be such that as the tuning is changed the frequency of the input circuit must differ from the frequency of the local oscillator by a constant amount which is equal to the frequency of the intermediate-frequency circuit. Although this requirement would seem to be more difficult to fulfil than the "straight" receiver's requirement of equal frequencies, there are—as will be seen later—various considerations favouring the choice of the superhet principle.

In addition to the method of mechanical coupling mentioned above, a coupling giving simultaneous control of the various magnetic variometers can readily be obtained by the arrangements shown in Figs. 1 and 2, where the variometers are connected in series or parallel to a common regulator and a common source of magnetic-bias current. In these diagrams the "tuning" magnets of three variometers are shown; their high-frequency cores, with their oscillatory-circuit windings, are omitted for the sake of simplicity. R4 is the common regulating resistance, and B the common source of current. Additional resistances, R1, R2, and R3, are also provided.

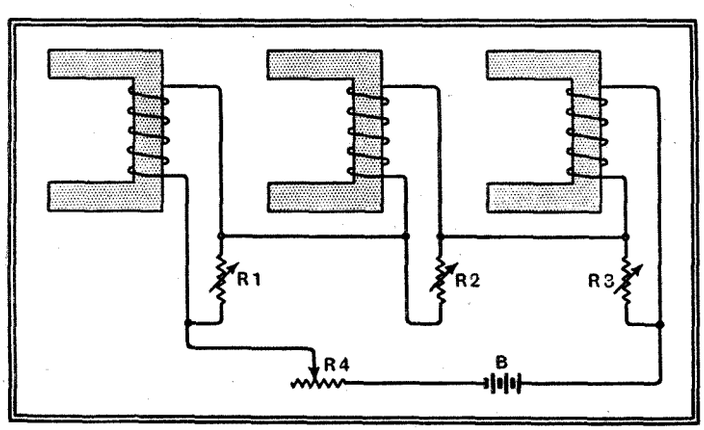


Fig. 1.—Skeleton diagram showing application of magnetic tuning to a 3-circuit TRF set. Main tuning is controlled by R4 which is in series with the fine-adjustment rheostats R1, R2, R3.

In the "series" connection of Fig. 1 these resistances are introduced in parallel with their respective magnet windings, while in the "parallel" circuit of Fig. 2 they are in series with their magnet coils. In the former case they are of considerably higher resistance than their corresponding magnet windings, whereas in the latter case they are of considerably lower resistance. They play the part, in a magnetically tuned receiver, of the "trimmer" condensers in an ordinary receiver tuned by variable condensers. The discrepancies in tuning between the various individual circuits, due to differences in connecting-lead capacities and other factors, can be corrected by the separate adjustment of these resistances, which permit the inductances of their corresponding tuning circuits to be varied individually. If necessary the capacities of the various tuning circuits can also be corrected by the use of variable condensers or the addition of "trimmers" to fixed condensers.

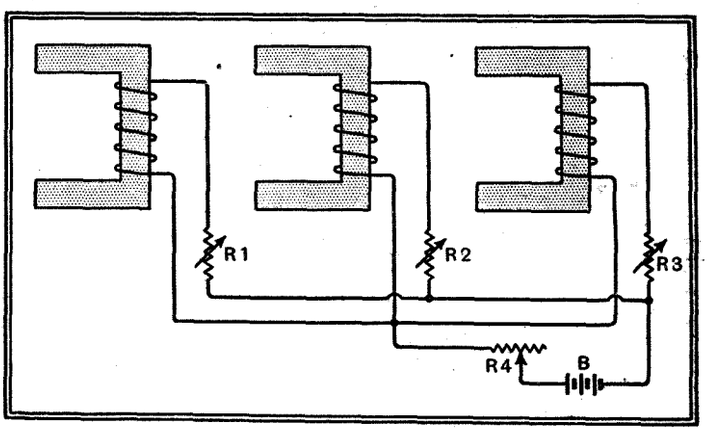


Fig. 2.—A similar circuit to that of Fig. 1, but with the "trimmer" resistances R1, R2, R3 connected in series with the electro-magnet windings

The arrangements shown in Figs. 1 and 2 thus correspond, in their action, to a system of three mechanically coupled rotating plate condensers, with the difference that the control element, the resistance R4, simultaneously varies the inductances, instead of the capacities, of the oscillatory circuits. In the preceding articles of this series a difficulty in connection with the scale calibration of magnetic variometers was discussed, and it was pointed out that unless expensive special materials were employed for the magnetic circuit a certain back-lash effect due to the remanence of the ferro-magnetic materials had to be taken into account. It might be expected that this difficulty would become serious in the case of the simultaneous tuning of several circuits. Fortunately, however, the normal production processes yield sufficient uni-

More About Magnetic Tuning—

formity to render the different variometers so similar in their behaviour that the backlash is practically the same for them all and interferes very little with the alignment of the "ganged" circuits. In this respect the magnetic variometers are, in fact, no more troublesome than mechanically ganged rotating condensers.

However, in cases where very exact alignment is necessary it will happen, as it does with ganged condensers, that the exactness is not satisfactory over a wide frequency range; for, even if the tuning elements themselves are perfectly matched, the differences in connecting leads and other disturbing factors may well be enough to upset the overall alignment. To avoid this trouble we may adopt the well-known plan of limiting the waveband so that the deviations in question become negligible.

Obtaining Accurate Ganging

In the case of ordinary variable-condenser ganging, each condenser may be provided with slotted end-plates, and the whole wave-band (say, 200-600 m) to be covered by the tuning adjustment may thus be divided into seven narrow subdivisions, corresponding to the seven segments of the end-plates; over each narrow wave-band exact alignment can be obtained by the suitable bending of the corresponding plate segment. A similar arrangement for the case of magnetic variometers is shown in Fig. 3 for a two-circuit combination. The two tuning magnets M1 and M2 are connected in parallel across the battery with the regulating resistance R1 in series. In the lead to M2 there is another variable resistance, R8, which is small compared with the winding resistance of M2. The current from the active part of R1 is led direct to R8 and its magnet M2, but reaches the magnet M1 only after passing through one or other of the separately set equalising resistances R2 . . . R7; which of these resistances is in action is determined by the position of the sliding contact on R1. In this way the total inductance range to be covered by the two variometers is divided, by the contact segments belonging to the resistances R2 . . . R7, into narrow sub-ranges which can be matched separately by the setting of these resistances; the result is that alignment errors over the whole tuning range are practically eliminated.

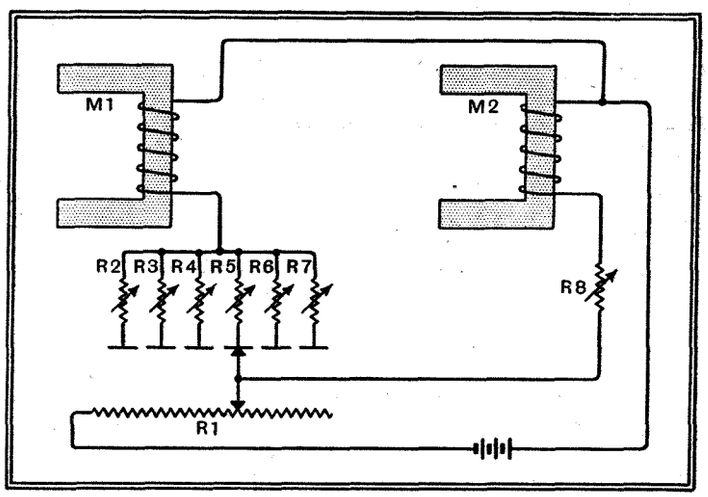


Fig. 3.—A correcting arrangement giving extremely accurate alignment; it is analogous to the split end-vane device in ganged condensers.

An arrangement according to Fig. 3 thus corresponds to two mechanically ganged condensers, one of which has an end-plate with five slits. As in the case of ganged condensers, it is not necessary to provide each tuning element with a separately adjusting correcting device; if there are n elements it is sufficient to provide $n - 1$ correcting devices. The resistances R2 . . . R7 can be of extremely simple type. A satisfactory form is found to be a small rod of ceramic material wound with bare resistance wire, as in Fig. 4, where the winding, W, is terminated at the two metal caps P1 and P2. The adjustment is carried out with the help of a soldering iron and a little solder by short-circuiting fewer or more turns of the winding; if too many turns are cut out, this can easily be corrected by brushing away the hot solder with a wire brush, the winding being spaced widely enough to allow the bristles to pass between.

Such cartridge-fuse pattern pre-set resistances present the advantages of cheapness and high constancy. Moreover, if the main regulating resistance (R1 in Fig. 3) takes the form of one of the usual commercial variable potentiometers, where the resistance strip, on an insulating carrier, is bent into a circle and is rubbed by a concentrically mounted springy contact arm, these cartridge resistances can be mounted in holes (parallel to the axis) in the base of the potentiometer, so that their metal caps, P1 (Fig. 4) form a circle of contact studs concentric with the resistance strip. Then the rotating spring contact, as it moves along the resistance strip, makes contact also with one after the other of the metal caps, passing from one to the other—if the width of spring and the spacing of the caps are correct—without a break.

One objection to the arrangement shown in Fig. 3 is that a separate remote-control lead is necessary for every tuned circuit of the receiver. If there is to be only a short distance between the control point and the receiver, this objection is not a serious one. But if the receiver is to be situated a long way away from the control point, or if an extensive system is involved in which the receiver is to be controlled from any one of a number of control points, it may be desirable to economise in the extra connecting lines by an arrangement such as is seen in Fig. 5; this is particularly the case if the receiver is to cover so wide a range of frequencies that it will be necessary to carry out changes of waveband.

In the arrangement of Fig. 5 the same sub-division of a waveband into a number of sub-bands for the sake of more accurate ganging alignment, is carried out, but in this case the switching over from one sub-band to another is accomplished *at the receiver itself* instead of at the control point. A remote-control switching mechanism is therefore necessary. Since, however, most receivers today have to cover so large a range of wavelengths that a waveband switch is an essential component in any case, this fact does not involve any great complication. It is true that the number of contacts on the wave-change switch must be increased, but this brings with it the following advantages in addition to the saving of a number of additional remote-control lines.

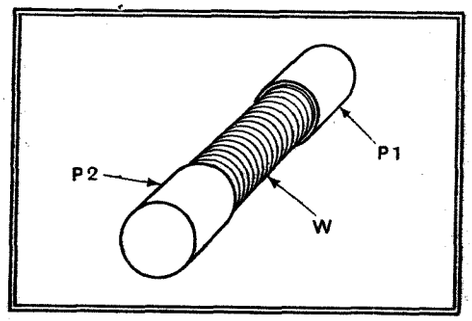


Fig. 4.—Construction of a correcting resistance for the circuit of Fig. 3.

Waveband Switching

The resulting reduction of the frequency band which has to be covered by a variometer means either that the necessary magnetic-control energy can be reduced, or that the damping of the magnetically tuned circuit can be diminished. Thus, in order to cover with the least possible expenditure of energy a frequency range of 1 : 3, the RF core of a magnetic variometer has, as a rule, to be made with a permeability rather greater than that of ordinary RF cores. The latter, constructed merely from the viewpoint of keeping down losses as much as possible, have a ring core permeability of from 10 to 20 (by ring core permeability is meant the permeability of an RF core material as measured on a closed ring of that material), whereas for the RF core of a magnetic variometer a value of about thirty-five has been found to be desirable, for the reason mentioned above.

If, however, in the arrangement of Fig. 5 the frequency range of the individual wavebands is considerably narrowed (and their number correspondingly increased) for the sake of more accurate alignment, then either the magnetic-

More About Magnetic Tuning—

tuning energy consumption can be reduced (or the magnet dimensions decreased) by retaining the material of higher permeability, or else this material can be replaced by the more ordinary RF core material, with a consequent diminution of the circuit damping. In the latter case it is also possible to introduce an air gap between the tuning-magnet poles and the RF cores, so that the latter are not in direct contact with the former. This also produces a diminution of the circuit damping, leading to values similar to those obtained with good RF iron-cored coils.

The arrangement shown in Fig. 5 has a further advantage in that it provides a form of fine adjustment. In an ordinary condenser-tuned receiver there is, as a matter of course, a step-down gear between knob and condenser spindle, so that the knob must make a number of full revolutions before the spindle rotates through 180 degrees. This facilitates accurate tuning. On the other hand, in an arrangement on the principle shown in Fig. 3 the knob of the ordinary circular potentiometer turns only through about three-quarters of a revolution to cover the whole waveband corresponding to that covered with an ordinary condenser, so that tuning is liable to be as difficult as it would be with a condenser unprovided with a step-down gear. Of course, this difficulty could be overcome by providing the potentiometer with such a gear. But the arrangement of Fig. 5 obtains the required effect in a purely electrical manner, because the normal wave-range is converted into five or six narrow sub-ranges, and the knob of the control resistance R3 has, therefore, to be turned five or six times in order to cover the whole original band.

The drive for the wave-change switch may be provided by the leakage field of one of the tuning magnets. Thus in the diagram (Fig. 5) a lever, H, pivoted at A is mounted near the tuning magnet M1. It carries at its free end the ferro-magnetic armature X, which is acted on by the field of M1. The movements of the lever H are transmitted by the leaf spring Y to the ratchet wheel Z driving the spindle U, which carries the two triple contact arms V. These arms make contact progressively with the two sets of contact 11 . . . 16 and 21 . . . 26, to each of which is connected a pre-set adjustable condenser (or a fixed condenser of suitable value with a small trimmer condenser in parallel). These condensers are so graduated that in conjunction with the inductances L1 and L2, respectively, they form tuned circuits whose frequency ranges (as the inductances are varied) just overlap. If the original receiver had two wave-ranges, each of which is now sub-divided into four or five sub-ranges for the sake of better ganging, then each triple contact-arm must be provided with 2 × 4 or 2 × 5 contacts, distributed over a third of a circle if a triple contact-arm is used, or over 180 degrees if a double arm is employed.

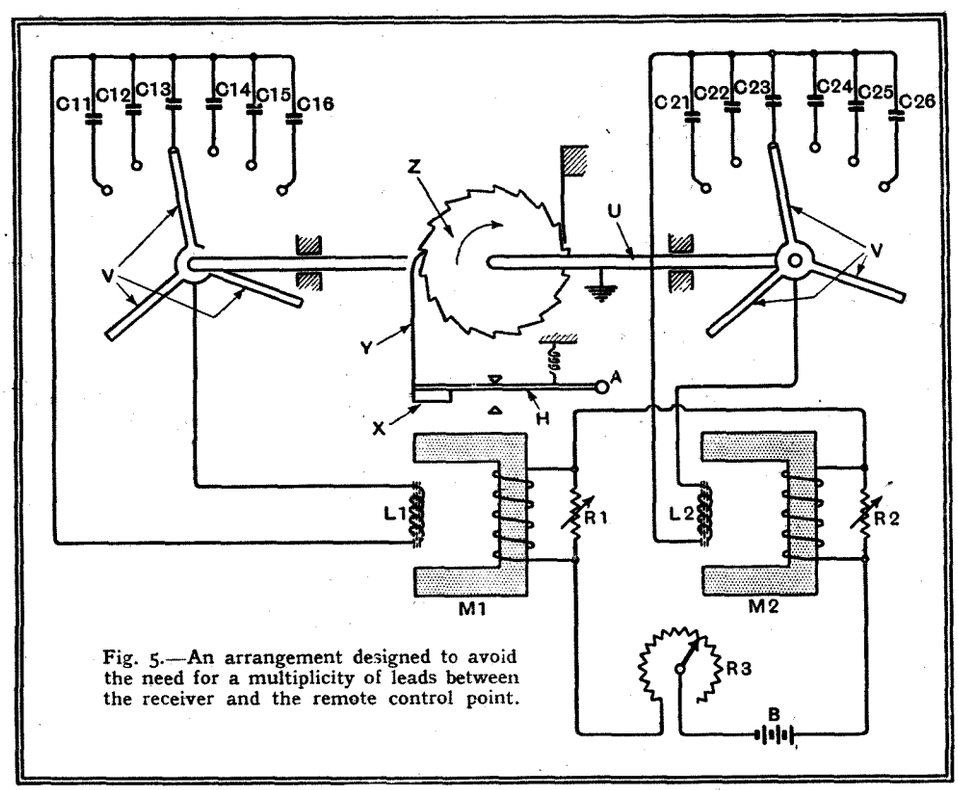


Fig. 5.—An arrangement designed to avoid the need for a multiplicity of leads between the receiver and the remote control point.

At every complete revolution of the knob of the tuning control resistance R3 a break in the current occurs as the contact-arm passes through the zero position. The lever H is released, and the ratchet wheel Z is moved on one cog to switch in a new waveband. If a Maltese cross or similar device is provided on the resistance R3 by which this is made to give a visual indication of the number of times the zero point has been passed through, and, therefore, of the relative position of the distant ratchet wheel Z, the waveband in action at the receiver is clearly indicated at the control point. Such a Maltese cross device must be provided with a stop to prevent it from being turned backwards.

An arrangement such as Fig. 5 provides an accuracy of alignment, an ease in adjustment (equal to that of any mechanical fine tuning), a low damping of the tuned circuits, and a simplicity in the matter of connecting leads to such an extent as to make it eminently suitable for the control of multi-circuit "straight" receivers; in fact, although these advantages apply particularly to the use of magnetic variometers, most of them would be found also if any other type of remote tuning were employed.

TELEVISION PROGRAMMES

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Vision	Sound
45 Mc/s.	41.5 Mc/s.

THURSDAY, JULY 7th.

3, "Rogues' Gallery," a review of the songs of law-breakers. **3.30,** British Movietonews. **3.40,** 161st edition of Picture Page.

9, Cabaret. **9.20,** Gaumont-British News. **9.35,** 162nd edition of Picture Page. **10,** News Bulletin.

FRIDAY, JULY 8th.

3-4.30, "On the Spot," a play by Edgar Wallace. Cast includes Arthur Gomez, Gillian Lind and Joan Miller.

9, "Speaking Personally"—Cecil Lewis. **9.10,** Catch-as-catch-can Wrestling. **9.30,** British Movietonews. **9.40,** Cartoon Film. **9.45,** "First Prize a Lady," operetta (Offenbach). **10.5,** News Bulletin.

SATURDAY, JULY 9th.

3, Cabaret. **3.25,** British Movietonews. **3.35,** "Thread o' Scarlet," a play by J. J. Bell.

9, Cabaret, including Hildegarde. **9.45,** Gaumont-British News. **9.55,** Music Makers. **10.10,** News Bulletin.

SUNDAY, JULY 10th.

8.50, News Bulletin. **9.5,** Ballet. **9.35,** Film. **9.45,** Irene Eisinger. **9.55,** Cartoon Film. **10.5-10.30,** Spelling Bee, III.

MONDAY, JULY 11th.

3, Contrasts. **3.15,** British Movietonews. **3.25,** "Bardell against Pickwick," scenes from Dickens' "Pickwick Papers." **3.55,** Cartoon Film.

9, "Speaking Personally"—Rosita Forbes. **9.10,** Cartoon Film. **9.15,** "A Knock in the Night," play by George Graveley. **9.30,** Gaumont-British News. **9.40,** "The Last Hour," play by George Graveley. **10,** News Bulletin.

TUESDAY, JULY 12th.

3-4.15, "The Case of the Frightened Lady," play by Edgar Wallace. Cast includes Walter Hadd, Cathleen Nesbitt and Frederick Piper.

9, C. H. Middleton: In Our Garden. **9.10,** Cartoon Film. **9.15,** "Ann and Harold," episode 1: Their First Meeting, story by Lewis Goodrich. **9.35,** British Movietonews. **9.45,** Contrasts. **10,** News Bulletin.

WEDNESDAY, JULY 13th.

3, "Androcles and the Lion," an old fable renovated by George Bernard Shaw. Cast includes Guy Glover and Esmé Percy. **4-4.20,** Preliminary O.B. from the Roehampton Club swimming pool.

9, Queenie Leonard and Richard Hearne in "For No Rhyme or Reason," and Lily Palmer and George Nelson in "Take Two Eggs." **9.30,** Gaumont-British News. **9.40,** Tennis Demonstration. **9.55,** Music-Makers. **10.5,** News Bulletin.

What is an Invention?

By "CATHODE RAY"

HIS Majesty's judges have long been wont to demonstrate their wisdom by seeking clear definition of terms, not asking such questions as "What is an intermediate-frequency permeability-tuned transformer temperature coefficient?" (which almost any schoolboy could answer) but really difficult ones like "What is love?" or "What is swing?" Among these terms that are almost too profound to be defined may be included "invention." A great many clever lawyers and patent experts and comptrollers and judges are continually trying to answer the question of what it is.

The general public never find any difficulty in it. To them an invention is something that comes to a particular type of person in a flash of inspiration, and which, after he has patented it, makes his fortune. Radio is an example of an invention, and Marconi was the inventor. Before him there was no radio; and after he invented it there was. Quite simple.

But quite wrong.

The question of who invented radio or anything else is generally much more difficult to answer in one word than who killed Cock Robin. Perhaps some bard will supplement our deplorably outdated stock of nursery rhymes with one for modern children on these lines:—

Who invented Radio?
Who laid the foundations
With his calculations?
I, said Clerk Maxwell,
I laid the foundations
With my calculations.

Who invented Radio?
Who detected the waves
With his resonator?
I, said Herr Hertz. . . .

And so on, at the rate of several stanzas a day until the infant dies in a hoary old age. Even if you select one particular branch of radio—television—and one particular appliance of the thousands used therein—the so-called electric eye—the idea of the invention springing maturely out of the inventor's brain, like the birth of Venus, is remote from the facts. As I pointed out some time ago,[1] although this device has only recently taken on practical form, it was described in all its essentials in 1911. It had to wait for perhaps twenty thousand other inventions before it could take its place in the scheme of things. Many widely separated branches of technique had to be elaborately developed before a successful "electric eye" could be made; but even if it could have been made in 1911 it would still have had to wait on the innumerable other branches of technique that have converged to produce the complex system known as television. An inventor can no more choose his own time for inventing than a slater or wireman can choose his time for working on a house. Inventing an Emitron in 1911 would have been like trying to fit the cistern when the foundations are being dug.

An invention, as commonly understood, is therefore generally the work of many people making their contributions at the right time and in the right way before the practical result can be realised. If an invention is made too soon, so that there is insufficient application or demand, or before means exist for making it available cheaply, the inventor "dies in poverty, while others reap his reward" in the approved melodramatic fashion.

Is the Patent System Breaking Down?

But wherein does the invention really consist? Is it what is commonly referred to as the inspiration or bright idea, or is it the practical working out? We generally associate an invention with the name of the bright idea merchant, who may or may not have gone on to accomplish the second and usually by far the most difficult and arduous part of the job. The ancient mythologists conceived the idea of man taking wings and flying, and even suggested a technique. Did they therefore invent the aeroplane? Or is the credit (or discredit) due to those who laboured for lifetimes to render the idea practicable?

Invention and Publicity

Various names are mentioned in connection with the invention of the moving-coil loud speaker. (One was patented, if I remember rightly, something like fifty years ago.) But the names of the metallurgists of Sheffield, who have been sensationlessly working for years to produce the cheap, light and efficient permanent magnets that result in millions, instead of thousands, of people being able to use them, are not likely to become very well known.

It is incredibly easy to get your name in a newspaper headline as the inventor of a new "wonder." In fact, a very small amount of cynicism is enough to drive one to say that the real utility of inventions is inversely proportional to the prominence given to them in newspapers. The work of making them manufacturable, often involving the co-ordination of a number of long lines of research, is not news. At what stage, then, is the thing "invented?"

A celebrated example of this problem is, Who invented the Valve? Did Fleming, who caused to be produced and applied what is now known as the diode, or did De Forest, whose addition of another electrode enabled the advantages of the valve to be realised in the variety of ways that has been essential to modern radio? Is a person who, by a slight alteration to what someone else has done, enormously expands its usefulness, entitled to less, equal, or greater credit than the someone else? And if a lot of people successively make additions, each in itself trifling, to what is ultimately very valuable, who is its inventor? And how much different has a thing to be in order to constitute a new invention?

These are not idle questions, but have to be definitely answered every day in dealing with patents. First of all, contrary to popular belief, you can't patent an idea. It must be some tangible embodiment, capable of being made by any skilled person from the information given in the specification. But because someone has invented a new process for rolling grid wires for valves, is somebody else entitled to come along and patent the same thing applied to the manufacture of hairpins? It is quite conceivable that something invented for some relatively obscure and restricted purpose—no doubt quite worth while in its own small way—may be found by somebody else to be applicable on an immense scale throughout the world for some such purpose as opening tins. Is the first man (whose thoughts ran far above tins) to draw royalties on 10,000,000,000 tins per annum? On the other hand, ought an inventor who has devised something with many potential applications to have no control over others who might patent the same thing as "as applied to . . ."?

It used to be relatively easy to see whether a thing did or did not come within the claims of a patent. But in these days of electrons and fields and plasmas the inventor himself may have quite the wrong idea about what he has done; so what chance has the lawyer to decide, perhaps at some later date when the art has greatly advanced, what the patentee is entitled to? What may seem very obvious later on may have necessitated real inventiveness at the time.

So although the patent system embodies

[1] "An Unsung Pioneer," Dec. 6th, 1935.

What is an Invention?—

a great deal of practical wisdom, there are signs that it is breaking down under the strain of the complexity of modern invention.

Patenting is much more expensive than most people suppose. To take out and maintain a single patent in the principal civilised countries costs thousands of pounds. And when you have done that, what have you got? Certainly not an unchallengeable right to control the use of the invention, or even to be considered the inventor. It is often said that all you really get is the right to defend your claim in the Courts. Of the hundreds of thousands of patents in existence, only a small residue could withstand every challenge that might be brought against them.

The effect of this is largely to neutralise the whole object of patents, namely, to encourage enterprise in invention. As things are, even inventors who can find the money to develop their work and pay the patent expenses may be deprived of the intended reward if they cannot call on almost limitless financial backing with which to deal with infringers and to fight vested interests that may stand in the way. On the other hand, firms or groups with sufficient resources can collect royalties on their own worthless patents and infringe other valuable patents with impunity.

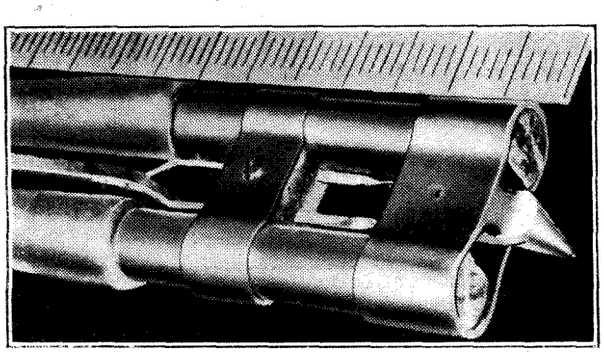
For these and other reasons there is a growing tendency to give up the expensive luxury of patenting; and, instead of working in secret, to publish the results of research at once. Then at least nobody else can patent it and so cause others to be deprived of its use.

What is an invention? It may be difficult to say, but at least it is not always the same thing as a patent.

A "Ribbon" Pick-up

MICROPHONE TECHNIQUE APPLIED TO PICK-UP DESIGN

OF the many factors contributing to the good performance of a pick-up, low inertia in the moving parts is probably the most important. In a new pick-up developed by F. V. Hunt and J. A. Pierce, of the Cruft Laboratory, Harvard University,[1] both mass and moment of inertia have been reduced to an unprecedented level by the application of ribbon microphone principles of construction.

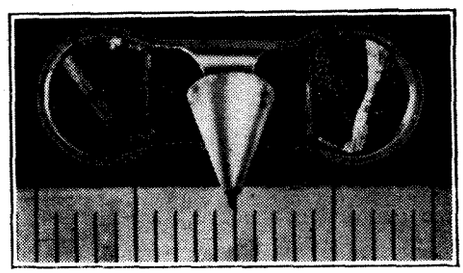


Plan view of "ribbon" pick-up showing arrangement of stylus holder, phosphor-bronze loop and cylindrical magnets.

A single turn of thin phosphor-bronze strip forms a loop in the transverse field between cylindrical magnets. The ribbon is attached at the closed end to a light aluminium conical shell which carries a sapphire stylus at its apex. This gives a system with a high stiffness/inertia ratio and there is evidence that it vibrates as a whole over the full range of uniform response of the pick-up. The total mass of moving parts is only 50 milligrams, or about one-fifth the mass of an ordinary steel needle. Sufficient damping is provided by the material used for the flexible membrane by which the closed end of the loop is connected to a small soft iron centre pole. As this damping is near to the axis of rotation non-uniformity in the elasticity of the material is unimportant.

The "moving coil" is matched to a 200-ohm line by a transformer which is mounted at the other extremity of the tone arm and serves as a counterbalance to reduce the needle pressure to the equivalent of 5 grams, all that is required to follow the heaviest recordings. As a matter of interest to those who have experience of home recording it is stated that the sapphire under normal pressure can be moved about on the surface of an uncut cellulose acetate blank without leaving any visible scratch.

Calibration by ordinary methods presents some difficulty, but a curve from 30 to 18,000 cycles has been deduced (1) by subtracting record and amplifier response characteristics from the overall response and (2) by recording up to 12,000 cycles at 33 RPM and then running this record at 78 RPM and comparing outputs bearing known ratios of frequency and needle velocity. It will be seen that the curve obtained in this way is remarkably flat and deviations from the average level do not exceed ±3 db between 30 and 18,000 cycles.



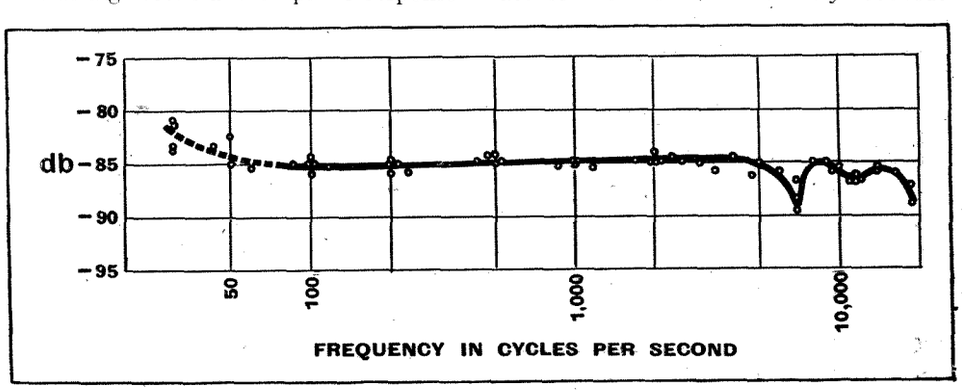
End view showing centre pole to which the aluminium cone is attached by a membrane of damping material. The small divisions of the scale shown in this and the preceding half-tone are millimetres.

As there is a mechanical step-down between the motion of the stylus and the ribbon, harmonic generation due to non-uniformity of the magnetic field is negligible.

Tests have been made to determine the degree of record wear on lacquer coated discs, and after 100 playings no measurable change either in frequency response or surface noise can be detected.

In spite of the relatively weak field in the experimental pick-up illustrated, no trouble was experienced in keeping hum pick-up below the level of surface noise. Neither was the instrument unduly fragile, for it could be dropped a distance of at least 1 inch on to the record without damage.

The pick-up was developed originally to enable an early play-back to be made of the records of the Harvard Tercentenary celebrations and for subsequent editing as historic documents. If the use of pick-ups of this type became general there is little doubt that manufacturers could give us much better records, since the stylus pressures and motional impedances are so low that the choice of materials for mouldings would not be restricted, neither would there be any necessity for the use of abrasives, and surface noise could be considerably reduced.



Over-all response characteristics, including output transformer. The reference level is six milliwatts for a velocity of 1 cm/sec. RMS at the stylus.

[1] *Electronics*, March, 1938.

UNBIASED

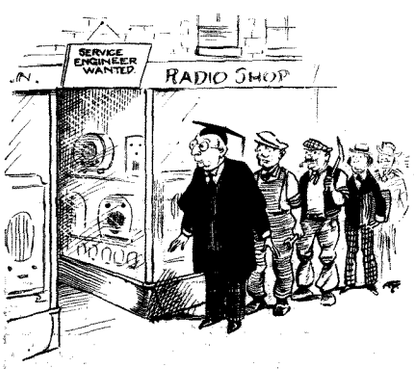
By FREE GRID

Snares for Servicemen

JUDGING from letters which have reached me it appears that my revelations concerning the tricks adopted by certain shady firms to get their repair work done free were very timely. The particular trick which I dilated upon was the old dodge of advertising a vacancy for a skilled man at an attractive salary. Naturally there are several applicants, each of whom is bidden to give proof of his skill by putting to rights a defective receiver that happens to be in for attention. Thus all the repair work is done by skilled men for nothing and the unfortunate applicants hear nothing further about the job. Naturally, each assumes that one of his fellow applicants was more fortunate than he was.

According to some of my correspondents this is not the only grouse that service engineers have when applying for a position. Very often an advertisement will appear for a skilled man with all kinds of high-falutin' academic qualifications. One of my correspondents tells me that he duly applied for one of these jobs and in addition to his other tasks he was expected to drive a delivery van.

On the other hand, it is only fair to state that the other side of the picture has been presented to me, as several highly respectable firms have written to tell me what they have to put up with from so-called servicemen who reply to their advertisements. In the first place, there is the totally unskilled applicant who thinks that servicing a modern wireless receiver is nothing more or less than a sort of glorified plumbing. He is soon disposed of, as is also the man with high academic distinctions, quite often a B.Sc. of some university, who is under the impression that a service engineer spends his time working out abstruse problems in a laboratory and receives a commensurate remuneration.



So-called servicemen.

The really dangerous type is the man with all sorts of paper qualifications and a glib tongue. He has often little or no practical experience and he can do irreparable damage to a dealer's goodwill as well as to his customer's sets before his delinquencies are discovered.

Radio and Riverside Romances

THERE are, I think, few pursuits more delightful than lounging back on the cushions of a canoe and slipping quietly down one of the glamorous backwaters of old Father Thames on a lovely summer evening, while a small portable wireless set grinds out suitable soft music. I was so occupied a few evenings ago, and was moving slowly along listening to the drowsy droning of the busy bees and the balmy burbling of the babbling brook when, suddenly, as my frail craft, carried along by the slow-moving stream, rounded a bend, my peaceful reverie was rudely disturbed by a raucous roaring from an approaching dinghy fitted with a small outboard motor.

I mentally anathematised these noisy contraptions but as the boat drew closer to me I was amazed to find that the terrible din proceeded, not from the outboard motor, but from an ancient-looking portable set which was quite obviously running in a badly over-loaded condition. Swiftly manœuvring my boat so that it was athwart the stream I forced the river-hog in charge to come to a standstill in order to avoid a collision, and, after reading him a sharp lecture on the criminality of mal-adjusting a wireless set, I proceeded to show how to tune in a programme properly.

To my surprise I found I could improve matters but little, and on investigating I found that the receiver was of a type dating back over a dozen years and so possessed no grid bias battery and a totally inadequate number of HT volts. Furthermore, the output valve, as were all the others, was of the old 0.06 amp. type which, as many of you will remember, had scarcely enough grid swing to handle a flea's concert let alone a man-sized one.

I naturally demanded to know why he used this ancient contraption when good modern portables were both plentiful and cheap, as, judging by the luxurious get-up of the boat, its owner didn't seem to lack the necessary cash. To my amazement he explained that actually he was a radiophobe to whom the proper reception of radio was a matter of complete indifference, and the sole reason he employed the set was to create a loud din.

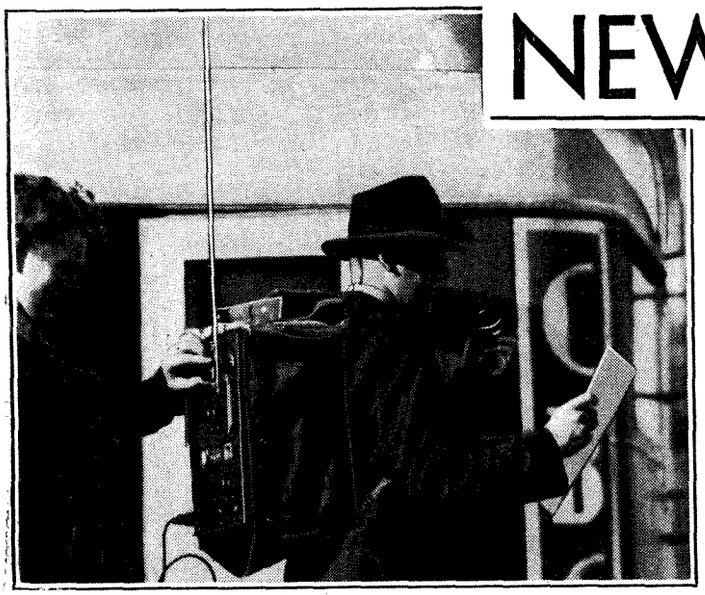
It appeared from his explanations that he had recently acquired one of the newly-marketed *electric* outboard motors which, on account of their almost complete silence, are mainly sold to fishermen desiring to creep up stealthily to their favourite casting ground. It seems that these little electric outboards have caused great indignation amongst the riverside fraternity who object strongly to their backwater philandering being disturbed by the silent and stealthy approach of this new menace to the amenities of the river.

In order to avoid discomfort to others, therefore, my newly-found acquaintance had fixed up an old set to use as a continuous warning of his approach, a gramophone being ruled out owing to the necessity of constantly winding it up. I am aware that the primary duty of radio is not that of entertainment but to be of service to the community, but somehow or other this latest example of it seems to stick in my gullet.

Backwater philandering.

This experience of mine has, however, fired me with the ambition to get an outboard motor for my own craft, but, needless to say, I do not intend to indulge in one of these new-fangled, silent, sleeky, slinky, electrical devices as I am not that type of person at all. I intend to get a good, honest petrol engine. There is one aspect of it that is troubling me, however, and perhaps you river folk can help me. My problem will be how to silence the motor so that it will not drown the noise of my portable wireless set. I do not, of course, refer to the electrical interference from the ignition system as I am quite capable of taking care of that myself. I am thinking of the ordinary mechanical noise of the thing. What is wanted, I suppose, is an engine that is totally submerged, as the electric one is, but that seems an utter impossibility.

NEWS OF THE WEEK



BOB BOWMAN, the ace commentator and special events director of the Canadian Broadcasting Corporation, using one of the USW transmitters of the C.B.C.'s new O.B. unit. He will be heard in the B.B.C. programmes on Tuesday next at 8, when he will be commentating on the fifty-fourth annual Calgary stampede in the Province of Alberta.

PHASE MODULATION—New Method of Transmission and Reception in U.S.A.

BEFORE the recent convention of the Institute of Radio Engineers, Mr. Murray G. Crosby, of R.C.A. Laboratories, described a new method of wireless transmission and reception which indicates that international broadcasts of the future will be transmitted over greater distances with four times the output of transmitters of present ratings. It is a phase modulation system, but it is thought that it will not affect broadcasting on the standard frequency bands because the most effective reception of phase-modulated waves requires receivers specially designed for the purpose. These would not need to be much more expensive than existing types, but the total cost and inconvenience of the mass change-over would mitigate against such a drastic alteration.

The system is essentially different in theory and operation from the existing method of amplitude modulation which impresses voice and other sounds on a radio wave to increase or decrease the strength of the wave in accordance with undulations of the sound that it carries. Phase modulation conveys a radio signal of constant maximum strength.

Variation or modulation of the new waves is accomplished by shifting the electrical oscillations so that they either precede or lag in their normal frequency of occurrence. In a receiver designed to intercept the vibrations in regular order, therefore, this change or phase shift will cause variation in response corresponding to the signal change.

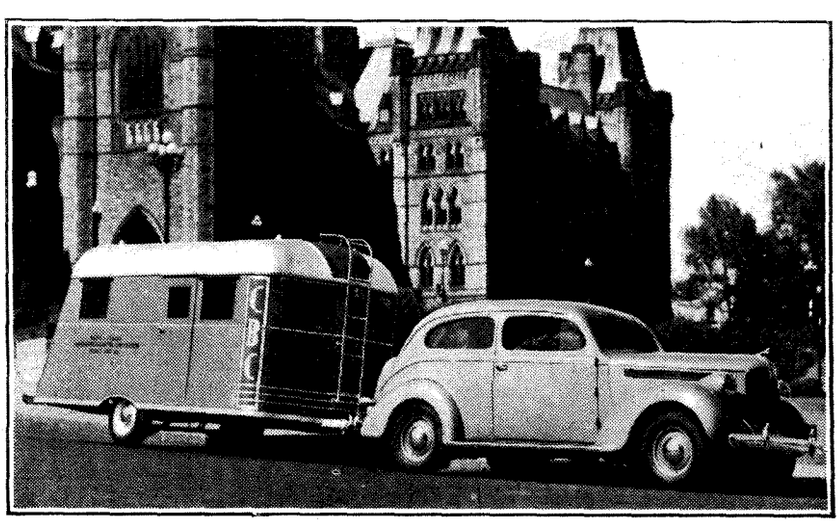
Although the general principles of transmission by this system have been known for years, it needed painstaking laboratory work to disclose a practical method of generating and utilising the waves to the best advantage.

CANADA'S FIRST MOBILE STATION

Combined Transmitter and Recording Plant

THE Canadian Broadcasting Corporation has built its first mobile broadcasting station and recording unit in a trailer. This station, which uses the call-sign VE9AZ and transmits on 37 Mc/s (8.108 metres), is equipped with the latest in portable ultra-short-wave transmitters and receivers and two recording units. For auxiliary power, when the unit is far from electric mains, a petrol-driven generator is carried in the towing car.

Sleeping accommodation for two engineers and one commentator is provided, and the trailer, which is completely copper-screened, has a roof observation stand for use by the commentator.



RADIO - CANADA. C.B.C.'s first O.B. and recording unit photographed outside the Parliament Buildings, Ottawa.

TELEVISION STATION IMPROVEMENTS

Better Programme Facilities

WE understand that the constructional work now in progress at the B.B.C. Television Station, Alexandra Palace, will make for greatly improved programme presentation in the autumn. The main feature will be the provision of a central control room with local control points for producers in each of the two studios. In this way each studio will be a separate unit, and it will be possible to conduct rehearsals in one while transmission is taking place from the other.

At present the limited number of camera channels available makes it impossible to rehearse during transmission time, with the result that each programme can be given only one "run through," with camera positions and lights, before being transmitted. Rehearsals are also held up during O.B.s, which have to be handled from the same control gallery as the performances in the studio.

Under the new arrangement outside broadcasts will be dealt with at the central control point without interference with work in the studios.

"LITTLE NATS." TO RE-OPEN DURING THE DAY?

WITH an increase in available funds the B.B.C. is, we understand, considering the possibility of resuming transmissions from the medium-wave National transmitters during the day. From correspondence arriving at Broadcasting House it appears that there are many listeners up and down the country unable to pick up Droitwich, and are thus restricted to the Regionals until 5 p.m.

RECORDING HISTORY

Current Affairs at First Hand for Posterity

SOUND recording and films provide a new and almost perfect medium for passing on the history of our times to posterity, and the B.B.C., fully aware of the necessity for organisation in this direction, has inaugurated an historical library of the spoken word.

Already there are many thousands of valuable records of the past in the possession of the B.B.C., and amongst these are such momentous speeches as were made by Lord Lee of Fareham, speaking on the problems of disarmament in 1909; H. H. Asquith discussing the Budget of the same year, when income tax soared to the unprecedented figure of 1s. 2d. in the pound; Walter Long on Irish Home Rule and an eye-witness account of the sinking of the *Titanic*. Such records as these made with the urgent address of actuality will provide first-hand accounts of history.

The International Broadcasting Union recently approved of a scheme for the international exchange of historical records, and it should be possible in the future to borrow from other countries such recordings which it has not been possible for the B.B.C. to make.

NOISY LOUD SPEAKERS

The B.B.C. Appeals to Listeners

IN the past fortnight or so the B.B.C. has been inundated with complaints regarding noisy loud speakers. The trouble is always prevalent at this time of the year, when french windows are flung open and the family has tea on the lawn.

The Corporation, however, hasn't a remedy and pleads with

News of the Week—

listeners to send their complaints, not to Broadcasting House, but to the local civic authority or the Post Office.

AMERICA SAMPLES BRITISH PROGRAMMES

Reception of Daventry in the States

IF the opinion of the *New York Sun* can be accepted as representative, the B.B.C. need have no inferiority complex in regard to the reception of its programmes by New Yorkers. Says the *Sun* radio critic: "It is possible to tune in any of the British stations at any hour and listen to the finest music, interesting commentaries, and news from overseas."

On the subject of short-wave reception, the journal says: "On 31 metres there is only one station that can hold a candle to GSB—that is GSG. You do not need an outdoor antenna for any of the British transmitters."

G.E.C. JUBILEE

AT the annual general meeting of the General Electric Company, held at Magnet House, Kingsway, London, on Monday of last week, Lord Hirst of Witton, chairman and managing director, presiding, pointed out that the company was entering upon its fiftieth year. During his address Lord Hirst, talking of radio and television, said: "The radio industry has, I regret to say, fallen on somewhat evil times and the lack of success in seeking to maintain list prices has aggravated the situation and made it very difficult. The future of television seems largely bound up with the ability of manufacturers to place models on the market having entertainment value and yet coming within the range of the public purse."

SURNAMES AS TONGUE-TWISTERS

HAVE you one of those strange-looking surnames which is pronounced precisely as it is not spelt? If so, the B.B.C. Advisory Committee on Spoken English has need of you. An appeal was issued recently to listeners to send a postcard to Broadcasting House, giving, as nearly as possible, the phonetic spelling of unusual names; but this appeal only drew some 150 replies. Perhaps, therefore, readers of *The Wireless World* who possess names which have as marked a difference between their spelling and pronunciation as, say, Marjoribanks or Beaulieu, will assist the B.B.C., which wants to compile a pamphlet for announcers on how to say surnames.

FIFTY YEARS' SERVICE

ON the occasion of the presentation of a radiogram to Mr. Charles Corbett, who recently completed fifty years of unbroken service with the Edison Swan Electric Company, Sir Felix Pole, chairman of the Associated Electrical Industries, recalled in the course of his address that Mr. Corbett had been in charge of the Ediswan Testing Department in 1904, when Sir Ambrose Fleming, then the company's consultant, evolved his thermionic valve.

FROM ALL QUARTERS

GOLD-BRAIDED POST OFFICE OFFICIALS arrange and control the technical side of O.B.s in Denmark. This photograph shows an engineer carrying a microphone during a recent relay from Copenhagen.

In the Small Hours

THE relay of the Louis-Schmeling fight in the small hours reminds us of the interesting fact that the B.B.C. has to obtain a special Post Office permit for transmitting after hours. Strictly speaking, it is not authorised to transmit after the first stroke of Big Ben at midnight, though no official has yet issued a challenge regarding the relaying of the other eleven strokes!

Marconi Feature Broadcast

LAURENCE GILLIAM, B.B.C. producer who was recently "lent" to the Canadian Broadcasting Corporation, is back in this country, and his first big task is to prepare a 45-minute feature broadcast on July 17th dealing with the life of Guglielmo Marconi.

Take Your Choice

ALL-INDIA RADIO is making a bid to interest more native listeners by publishing its programmes in two new journals, printed in Tamil and Telugu. Both journals will concentrate on the short-wave programmes from Madras and Trichinopoly.

America Hears "Brighton Nights"

THE transatlantic beam system was called into service for a broadcast relay last Tuesday, July 5th, when "Brighton Nights," the first of the series of seaside programmes, was relayed to American listeners on the N.B.C. network.

No Tax Reduction

IN view of the fact that the construction of a new Broadcasting House at Oslo will absorb a larger sum of money than was originally estimated, it has been decided not to reduce the cost of Norwegian licence fees from 20 to 15 kroner (£1 to 15s. approx.) as had been agitated.

Radio in the States

ACCORDING to recent statistics there are, in the U.S.A., no fewer than 725 broadcasting stations, and these are controlled by some 600 different companies. 280 of the stations are wholly or partially owned by newspapers.

New Relay Station

RECEPTION of B.B.C. stations in East Anglia has always been unsatisfactory, and the plan for a new relay station which was put forward a year ago is now taking a practical turn. A testing van is touring in the district around the Wash in order to find the most satisfactory site for the new station.

Indian Radio Development

THE Madras Broadcasting Centre of All-India Radio was recently opened by the Premier of the Presidency, Mr. C. Rajagopalachariar. Broadcasts are made in English, Tamil and Telugu; Western and Indian music, news and plays, are radiated.

New Wireless School

A TEMPORARY school to accommodate approximately 3,000 airmen pupils and a staff of about 200 airmen and civilian instructors is to be opened in the autumn at Yatesbury, Wiltshire, in order to meet the increased requirements of the R.A.F. for wireless personnel. A site for the permanent school is being chosen elsewhere.

Explorer's Link with London

THE Admiralty has given permission for a naval telegraphist to accompany this year's expedition of the Public Schools' Exploring Society, which leaves England for Newfoundland on July 29th. Experimental wireless messages from the Expedition will be dealt with at the receiving centre in Whitehall.

French Interval Signal

THE French short-wave station, Radio Mondiale, has introduced a few bars from the "Marseillaise" as an interval signal.

262,500,000 Listeners

FIGURES issued by the International Union of Radiodiffusion placed the known number of wireless receivers throughout the world at approximately 70,000,000. Assuming an average of 3.75 persons per family this places the total number of listeners at 262,500,000.

Modern Town Crier

BRESLAU is the first town to be equipped with the elaborate PA installation to be erected throughout Germany in the next few years. Breslau's equipment consists of 100 of the special loudspeaker columns or kiosks.

Lonely Telegraphists

WILLIS ISLAND, a tiny sandspit, 250 miles off the coast of Queensland, Australia, is the lonely home of two wireless operators who are the only inhabitants of the island. They are stationed there for twelve months at a time by Amalgamated Wireless of Australasia, and their job is to transmit, at regular intervals from 6 a.m. to 9 p.m. daily, weather reports which are picked up at Townsville.

Turkey on Short Waves

THE new Turkish short-wave broadcasting station at Ankara, working on 19.74 and 31.7 metres, will be put into service on July 22nd.

Will Car Radio Boom?

LATEST estimates place the number of car radio installations in this country at between 40,000 and 50,000, or approximately 2½ per cent. of cars on the road, while 20 per cent. of America's cars are radio-equipped.

Voice From the Desert

A WAR OFFICE Experimental Convoy is to spend some weeks in the Egyptian Desert collecting data as to the serviceability of certain vehicles in difficult conditions of country and climate. The convoy will maintain wireless communication with Cairo and broadcast reports of its daily progress.

School for Conductors

SIR ADRIAN BOULT, B.B.C. Director of Music, is to give a course of lectures to conductors and some of the members of the B.B.C. Music Department at a week's summer school to be held at his home in Surrey. The evenings are to be spent listening-in.

"Time and Tide . . ."

IN order to prevent speakers in triangular discussions on the N.B.C. network over-running their allotted time, three warning lights have been installed in each of the three sides of a new triangular table which, built up like a beheaded pyramid, is to be used by the debaters. The coloured lights flicker warnings at 2 minutes, 1 minute and 10 seconds before the speaker is to stop talking.

A Case for Remote Control

A LISTENER writing to the *African Radio Announcer*, Johannesburg, says: "London has altered its News service to 7.20 p.m. This does not matter to townspeople, but it is very awkward for country listeners, as this is the time for an evening meal and the set might be some distance from the dining-room."

Slow-Speed Discs

HINTS ON RECORDING AT 33⅓ r.p.m.

LARGE-DIAMETER discs, running at slow speed, offer the advantage of exceptionally long playing time. In this article suggestions are given for obtaining the best results from this specialised method of recording.

By H. W. DAWES

INSTANTANEOUS recording at 33⅓ r.p.m. or slow-speed records has many practical uses, especially in the recordings of radio programmes and home talkies. Good recordings can be made if care and patience are exercised and the recordist pays attention to every detail, no matter how small. In this article the writer will attempt to remove some of the snags which have probably caused many an amateur recordist to give up in disgust.

One 16in. slow-speed disc will play for approximately 15 minutes per side, and this long playing time will appeal to most, as a long programme is available with the minimum break between each record, and when used for home talkies it is possible to use one disc for each reel of film, thus being able to film and record a complete action without the trouble of having to keep fading in and out fresh discs every few minutes, according to the size of disc being used.

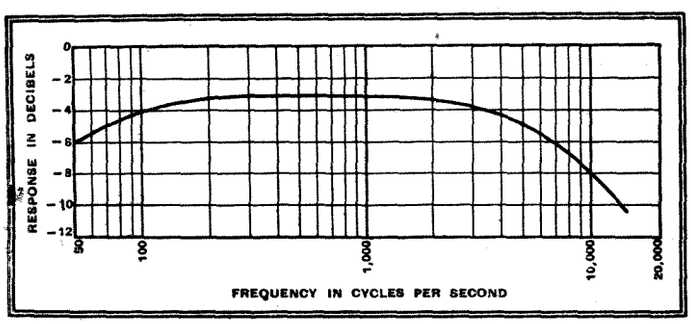


Fig. 1.—Suitable characteristics of a recording head for working at slow speed.

Recording at slow speeds entails more problems than at 78 r.p.m. The following table shows the tangential velocities of high- and slow-speed records, and a glance will show that the needle speed is very much lower on slow-speed records.

Location of Groove	Tangential Velocity in Inches per Second.	
	78 r.p.m.	33⅓ r.p.m.
Inside ...	16.25	13.5
Middle ...	31.5	20.5
Outside ...	46.5	27.5

It is difficult to make good recordings on the inside grooves of the record, because the decreased needle speed makes the available track for recording shorter. This is especially true when recording high frequency modulations, which are recorded with very little amplitude. This small amplitude represents considerable energy, and if the needle is sharp no difficulty is experienced in reproducing these modulations. It is for this reason that slow-speed recording should always commence from the inner groove. The diameter of this groove should not be less than 7½in., as anything smaller will certainly be detrimental to good quality.

Though surface noise is more pronounced at slow speed, the fitting of a scratch filter is not recommended. This will cut out practically all frequencies over 4,000 c/s and the recording will lose its brilliance. It is better to make suitable correction to the recording amplifier. When making this correction the frequency responses of the recording head (or pick-up) and the material on which the recording is made must be taken into consideration. The curve of a suitable recording head is shown in Fig. 1, while Fig. 2 shows a suitable curve for the recording amplifier.

The recording amplifier should have a surplus gain of at least 15 db. The curve of an aluminium disc is lower at 8,000 cycles than 10 db. and "scratch" is due to the hardness of the material and the angle of the diamond in the recording head. The aluminium should be of medium hardness and well lubricated. The diamond cutter should set in the recording head at a steep angle as shown in Fig. 3 and the diamond itself be ground to a suitable shape, so that it will not rip or tear the record instead of compressing it.

When reproducing instantaneous recordings the proper placing of the pick-up is most important to good quality. With 78 r.p.m. records it is usual to place the pick-up so that the needle hits the exact centre of the turntable. Because of the fairly short radius of the record this is considered the proper position, but for 16in. records this rule does not hold good. When recording, the cutter is guided in a straight line across the record, and obviously the correct way to reproduce would be to have the pick-up travel across the record in the same way. As this would not be practical for commercial purposes, owing to the necessity for a feed screw and gearing, the placing of the pick-up is such that practically straight line tracking is obtained. If the pick-up is placed in the same position on the 16in. record we find that from start to finish the arc described has a comparatively short radius. Therefore the plane of the pick-up is not perpendicular to the plane of the record and fidelity will suffer. The pick-up should be placed as shown in Fig. 4, and the pick-up arm should be at least 12in. long.

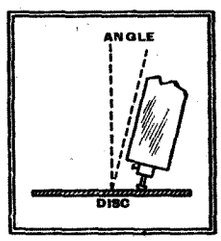


Fig. 3.—The cutter should be set at a steep angle.

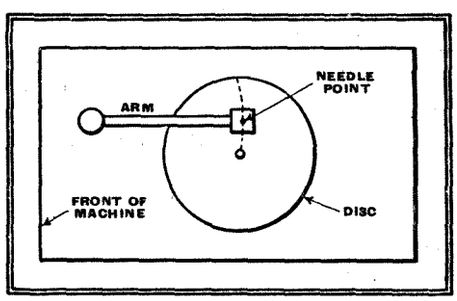


Fig. 4.—A long pick-up arm, placed as shown, gives best tracking on a large slow-speed record.

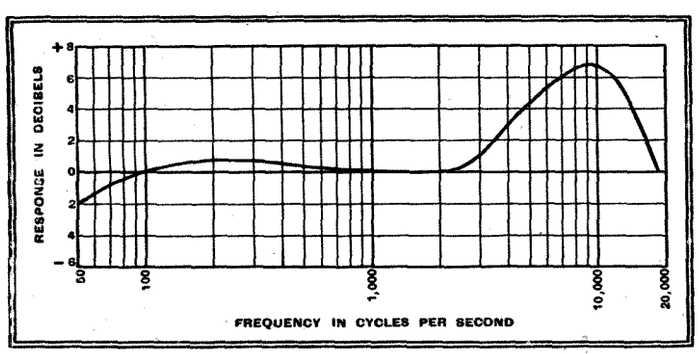


Fig. 2.—A recording amplifier giving high note accentuation is recommended for use with a cutting head having the characteristics of Fig. 1.

In conclusion, the correct choice of playback needles, bearing in mind the shape of the record grooves, will go a long way to eliminate hiss and scratch and prolong the life of the recording. A sharp pointed needle in a V groove should be avoided; if the angle of the needle point is such as will

Slow-Speed Discs—

allow the point to touch the bottom of the groove, the needle will pick up hiss, due to the dust and foreign particles lying at the bottom of the groove. The point should actually ride above the bottom and bear on the walls only of the groove.

The fibre or thorn needles, unless specially treated, wear out before the end of a 16in. record is reached, but experiment has shown great possibilities with a soft type of steel needle bent to an angle of 40 deg. to 45 deg. and used with a pick-up set very nearly vertical to the record.

It should be noted that these points apply equally to 78 r.p.m. recording, and are well worthy of consideration by the recordist interested in the higher speed.

N.P.L. Annual Visit

WHAT is sometimes described as the annual tea party was given by the National Physical Laboratory at Teddington this year on June 28th. Actually this event provides an opportunity for those favoured by an invitation to see what the Laboratory has been doing during the past year in the particular branch of science in which one may be interested.

Though officially concerned only with the wireless section, it was difficult to curb one's interest in the many other activities of the Laboratory. However, once the Radio Section was located there was no desire to leave the field in which this year's demonstrations were being conducted.

The main feature of interest was a wireless-equipped meteorological balloon for obtaining information about atmospheric conditions.

A small transmitter working on a wavelength of 8.5 metres has been developed, which weighs only 4½lb., complete with batteries and assembled in a metal container measuring 6in. in diameter and 9in. high.

From the moment the balloon is released it transmits continuously, the carrier being modulated by two AF oscillators the frequencies of which vary according to atmospheric pressure and temperature respectively. The changes in the modulating oscillators are effected by using miniature iron-cored coils and arranging for the air-gaps to be varied, in one case by a small bellows-type aneroid and in the other by a wire stretched along an invar bar. The length of the wire varies with temperature and so alters the air-gap.

The variations in the two modulation frequencies in the receiver thus give the atmospheric pressure, which is easily converted into height above ground, and the temperature obtaining at that height.

At the same time the flight of the balloon is followed by an ultra-short-wave direction finder. During the demonstration the radioed data received was plotted in the form of curves on a blackboard so that in imagination one could follow the excursions of the balloon in the upper atmosphere. Released soon after 3 p.m., the tests terminated approximately one hour later, when the balloon burst at a height of just under eight miles, the temperature at this height, according to our radio robot, being −70 degrees Centigrade.

It is claimed that the height of the balloon can be calculated from the pressure to within about 100 yards. If two or more direction finders were used, it would be possible also to obtain information about wind direction and velocity during the flight.

The bursting of the balloon does not result in the destruction of the apparatus, as attached to the transmitter is a parachute which allows it to come gently to earth. Visual tests show that up to 30 miles the accuracy of the radio bearings are correct to within about 2 degrees, and observations have actually been made up to 60 miles with only a slightly lower accuracy.

There were several other pieces of apparatus, one for field-strength measurement on ultra-short waves and the investigation of wave propagation, but these were rather eclipsed by the new equipment described for meteorological observations. H. B. D.

Tendencies in American Receiving Valves

GLASS v. METAL TYPES

ACCORDING to the data periodically released by the Radio Corporation of America the tendency of receiver designers to return to class A output valves and glass envelope types has continued during the last six months. Among the metal shell valves, which have lost ground to their glass equivalents, are the 5T4, 5W4 and 6X5 rectifiers, the 6C5 and 6J5 moderate-μ triodes, the 6F6 output pentode, the 6L7 frequency-changer of the 5-grid variety, and the diode-triode valves known as 6R7 and 6Q7. However, it is only fair to note that the 6L7 has not given way only to the glass equivalent, but is in part displaced by another metal shell valve, the 6K8 triode-hexode, which is advantageous at higher frequencies. There is a reversal of this general tendency among the RF pentodes, however, where the metal-shell types 6J7 (sharp cut-off) and 6K7 (variable-mu) have gained with respect to their "G" equivalents. This is a pure concession to convenience of design and simplicity of manufacture—a shield "can" is saved.

The abandonment of class B audio for receivers is now almost complete. Thus the high-μ zero-bias twin-triodes have dropped out of popularity, whether their shells be of glass or steel, except only the battery 2-volt type called 1J6-G.

The beam-type of loud speaker tetrode has fallen in popularity, too, probably because of the disappointing performance of such valves in the presence of poor regulation of the anode supply. The very poorest reproduction heard for years came from receivers employing a single beam-tetrode under adverse conditions.

The valves so far mentioned are all of the "octal-base" type. This feature of the metal-shell valves is becoming almost universal.

Among the newer valves there is nothing noteworthy save the 6K8 triode-hexode already mentioned, and the steep-slope 1851 pentode, which, at 300 volts anode and 150-300 volts screen potentials, affords a mutual conductance of 9 mA/V., as compared with approximately 1.2 mA/V. for other recent American valves. The 1851 has a metal-shell, an ordinary octal base, and is priced as a receiving valve, but somewhat curiously bears a "miscellaneous" number and must be purchased through special channels.

The miniature baseless acorn types are increasingly popular. They are employed in portable AF amplifiers as well as in the ultra-short-wave devices for which they were originally intended. Although they are still listed as "miscellaneous" valves the price has come down until it is not much more than twice that of normal valves.

COSMOCORD

GRAMOPHONE UNIT

THE latest Model 110 is a remarkably neat product from whatever angle it is reviewed. The lines are simple, the combined drop front and slide action is light and smooth, and the weight of the whole component is surprisingly low.

A crystal type pick-up is fitted and the head swivels to facilitate needle changing.

Volume and speed controls are provided and the motor is fitted with an automatic start-and-stop switch.

The overall dimensions are 19¾in. by 14½in. by 9in., and the price is £5 10s. for AC mains or £6 10s. with a universal motor. It is undoubtedly the product of a firm with a thorough understanding of gramophone requirements, and its light weight and general handiness should commend it to those who wish to take advantage of the pick-up terminals on their table model receivers.

Model 110 "Cosmogram" playing desk with crystal pick-up as it appears when open and when closed.

Television Topics

MAGNETIC FOCUSING

IN the design of magnetic focusing systems for cathode-ray tubes in television receivers one of the difficulties is to maintain a constant current through the focusing coil. This is necessary because it is usually desirable to wind the coil with copper wire, and copper has a relatively high positive temperature coefficient of resistance. In some cases it is necessary to maintain the current, and hence the flux, to a constancy of the order of ± 1 per cent. of the chosen value, and in normal focusing coil design it is possible

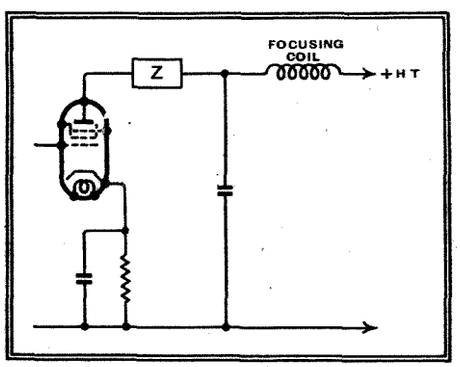


Fig. 1.—Compensation by means of a screened pentode valve.

to get a 10 per cent. change in resistance corresponding to some 30 deg. C. rise in temperature.

The effects of this variation of resistance can be compensated partly or completely by various methods. For instance, the focusing coil can be placed in the anode circuit of a valve of the pentode type in which the screen potential is maintained substantially constant as shown in Fig. 1. Under these conditions the anode current is practically unchanged by variations in anode potential. The resistance of the focusing coil is made low so that the valve may be used for normal amplification purposes and the current is little affected by the resistance of the coil.

Alternatively, a circuit such as Fig. 2 may be used. Here the focusing coil is split into two parts. One coil has n turns and is connected in the anode circuit of a valve with an anode current i; the other coil has n_1 turns and carries the current i_1. A change in i or i_1 due to increased resistance of the two halves of the focusing coil acts to reduce the grid bias, setting up a new value of i which restores the value of $(in + i_1n_1)$ to normal.

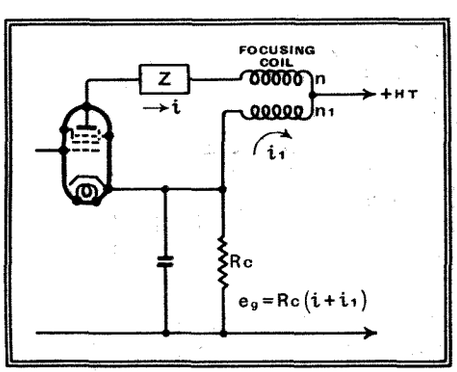


Fig. 2.—The use of a split focusing coil.

Still another possibility is to place the focusing coil in the anode circuit of a valve having a very high resistance at Rc (Fig. 3). The grid is returned to a point on the potentiometer R in order to restore the anode current to normal. A small reduction in anode current due to increase in the resistance of the focusing coil reduces the grid volts (Ia Rc), thus tending to restore the value of the focusing current (Ia). Both in this circuit and in that of Fig. 2 it is intended that the valve shall be used for its normal duty at the same time.

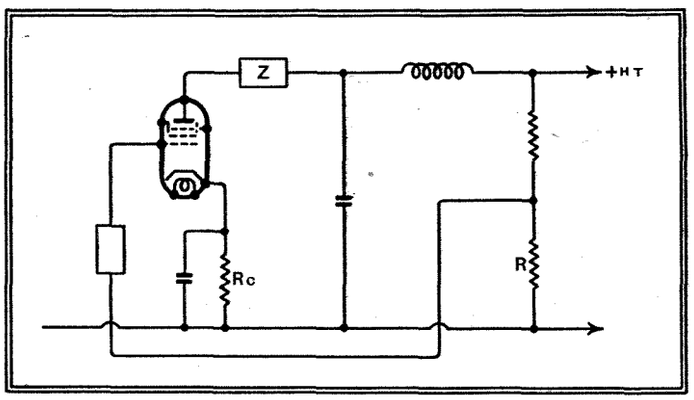


Fig. 3.—The action of the cathode resistor Rc tends to maintain constant anode current.

A Bridge Circuit

Turning to methods which do not involve the use of valves, the coil may be fed with current from the HT line in series with a resistance having a negative temperature coefficient of resistance and having such a capacity for heat and magnitude of resistance that the rate of decrease of resistance with time is equal to the rate of increase of resistance of the focusing coil with time. For this purpose it is necessary to enclose the resistance in a material such as grease or oil contained in a suitably proportioned metal container.

Alternatively, a copper coil may be shunted by a resistance made of copper or other metal of high positive resistance temperature coefficient and running at a higher temperature than the focusing coil. The ratio of the hot resistances can be chosen so that a higher proportion of the whole current flows in the focusing coil, but tending to a constant value.

A form of bridge circuit can also be used as shown in Fig. 4. Here a shunt-fed focusing coil is split into two main parts and connected to form the opposite arms of a bridge network with two substantially constant resistances. The detector points on the bridge are closed through a further compensating winding so connected as to make the sum of $m + n_1i_1 + n_2i_2$ approximately constant.

In view of these difficulties it might seem that a permanent magnet system would be simpler than an electro-magnetic one. It is by no means easy to find a permanent magnet system which enables the strength of the magnetic field to be varied for focusing. However, the difficulties can be overcome by the arrangement shown in Fig. 5.

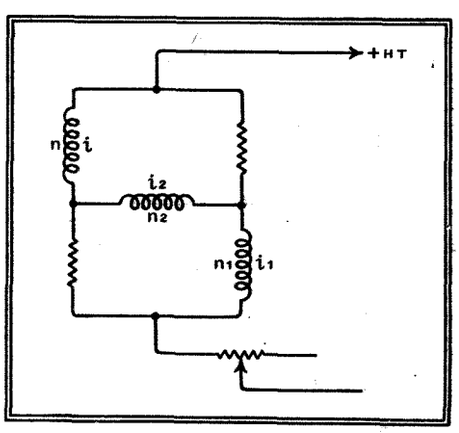


Fig. 4.—A circuit in which the split sections of the focusing coil form the opposite arms of a bridge network.

A piece of magnetic alloy which is approximately tubular, both ends being ground flat and parallel to each other, is produced in the usual way. This tubular magnet is magnetised parallel to its axis, and is represented by A of Fig. 5. On to this magnet are fitted two annular discs, B and C, of soft iron. One of these, C, has its inner and outer edges shaped to suit the desired magnetic field. The other, B, has threads on its inner and outer edge. Both discs and the magnet A are held

Television Topics—

together by screws of non-magnetic material, F, which may simultaneously hold the arrangement together and fasten it to the support G, of non-magnetic material. Into the inner thread of the disc, B, is screwed a tubular piece of soft iron, D, the end of which may be shaped to suit the desired magnetic field. By screwing it in the disc, B, any desired slot width between C and D may be obtained. The outer thread of the disc, B, carries another tubular part, E, of soft iron. By screwing this around the disc, B, any distance between E and C may be obtained. This piece E serves, therefore, as a shunt to the magnetic flux of the magnet, A, and by adjustment of the distance between E and G the strength of the magnetic lens may be varied.

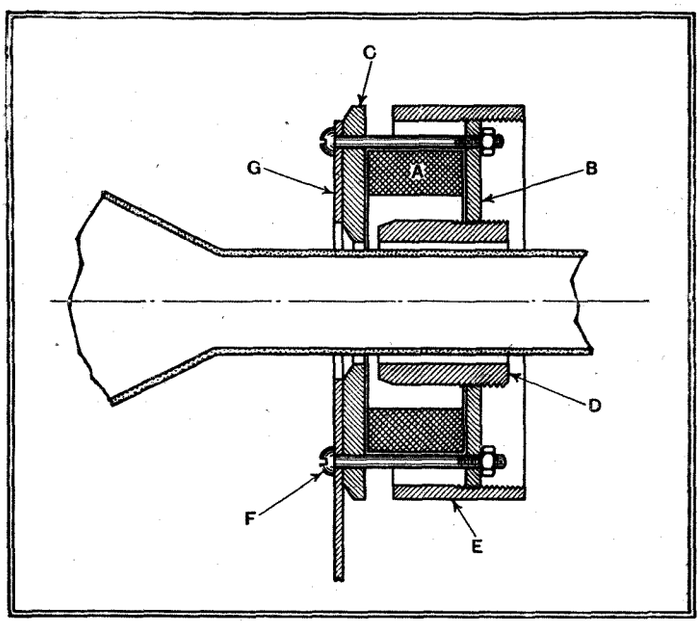


Fig. 5.—A focusing system using a permanent magnet.

German Television

FORM OF SIGNAL TRANSMITTED

THE German Post Office Television Laboratories have now published details of the television system to be used for the 441-line public programme service which is to start shortly. In the official publication it is intimated that the standard of 441 lines will be adhered to for a period of years. The technicians, however, are fully aware of the fact that they can produce much higher definition in the laboratories, and also that for large-screen projection reception 441 lines will not be enough, as the public automatically compares such pictures with the cinema screen. Laboratory work will, therefore, be continued to make the present achievements practical and to place them on a service basis. Until then, many years may pass, and in the meantime 441 lines will be employed as the best compromise between present development and practical requirements of engineering and finance.

The first demonstrations of 441-line reception took place in Berlin at the time of the Radio Exhibition in August last year. During the past winter a series of test transmissions has helped the post-office engineers in their work to find the best possible synchronisation signal for the transmissions. This has now been published.

As already stated, 441 lines will be used, with 25 full frames per second. The scanning will be interlaced, thus giving 50 frames of 220.5 lines.

Modulation will be applied to give a white light spot at maximum and a black one at the minimum. Only three-quarters of the modulation depth will be used for vision, and in the part below "black" about 25 per cent. of the whole will be used for the synchronisation signals. The average value of the image brightness, called the DC component, will also be transmitted.

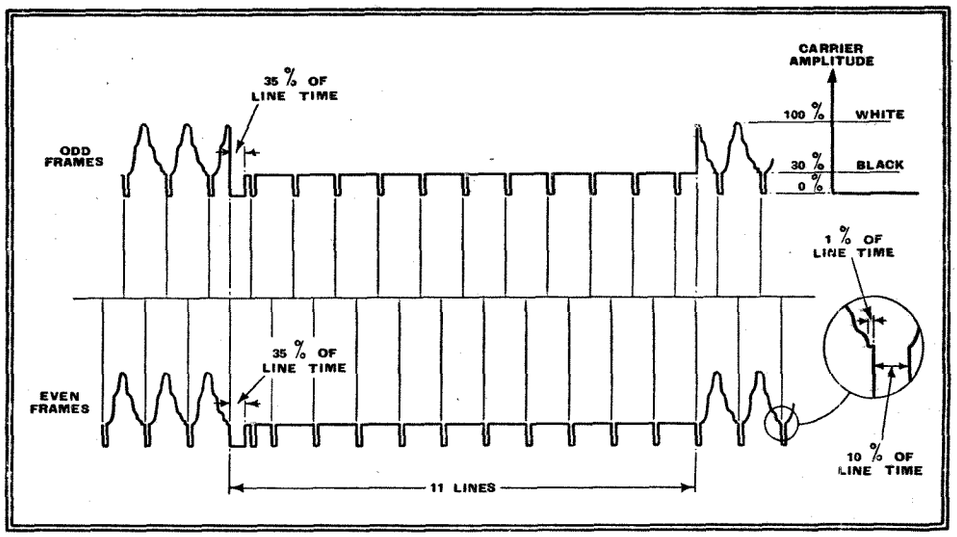
The frequency separation between image and sound carriers will, for all German stations, be 2.8 megacycles. The Brocken transmitter will operate on 7.5 metres for sound and 7 metres for vision, Berlin and Feldberg will operate on 6.6 metres for sound and 6.28 for vision. This arrangement leaves space for a further television station in the allotted band. It will be seen that the sound-carrier frequency has in all cases been chosen smaller than that of the vision transmitter.

The synchronisation of the television transmitter and receiver is achieved by the introduction of synchronisation signals. The accompanying diagram, which is by courtesy of "Fernsehen und Tonfilm," gives exact details.

For the cable transmission of television both for relaying between station and station (Berlin to Brocken, for instance) and for wired distribution of television, a comparatively low-frequency carrier must be employed to prevent an increase in the number of repeaters necessary. The frequency decided on is $441 \times 50 \times 180 = 3.969$ Mc/s. This frequency can easily be produced by frequency multipliers. For cable transmission only the lower band from four to two Mc/s will be transmitted. It is possible that the carrier will also be suppressed so that the cable can be used to full capacity. The comparatively small carrier frequency produces certain difficulties in modulation and demodulation, but these are much less disagreeable than the adaptation of the cable to work with a really high carrier frequency.

For wired-wireless television the sound accompaniment for the vision will be broadcast on one of the wired high-frequency wavelengths, as the remainder of the cable capacity, below one Mc/s, is occupied by trunk telephones.

These are, very briefly, the standards of the new German television service. Should readers be interested in the fundamental report on the exact results of the experiments and the reasons for the shape of the synchronisation impulse, etc., they can turn to an article published by the Post Office Laboratory in the May issue of its official scientific paper, where the whole theory is to be found.



This diagram shows the form of the signals radiated by the new German station. There are 441 lines interlaced for twenty-five complete frames.

Readers' Problems

A Selection of Queries dealt with by the Information Bureau, and chosen for their more general interest, is published on this page.

A Matter of Frequency Coverage

A READER wishes to know why the tuning on his all-wave receiver is so much more critical on the short waves than on the normal broadcast ranges, as the same tuning arrangements and condensers are used.

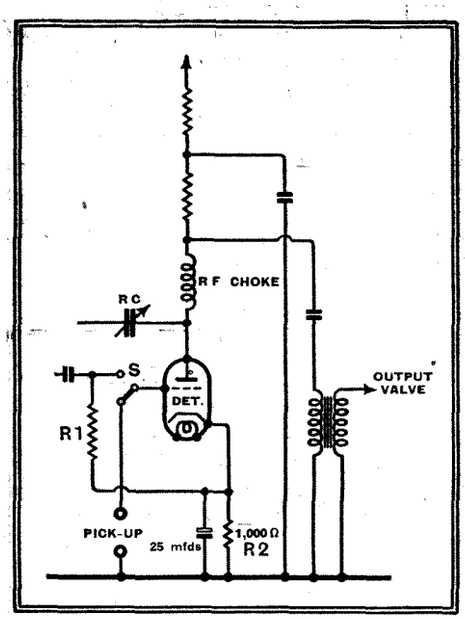
This condition is, of course, not uncommon, and in order to explain it one must take into account the frequencies covered on each of the wavebands in question.

On the medium-wave range the usual coverage is 1,500 to 550 kc/s, i.e., 200-550 metres, which represents 950 kc/s change, or 95 station-channels of 10 kc/s each.

The short-wave range, if one band only is provided, probably tunes from 19 to 48 metres which, in frequencies, represent 15,800 to 6,250 kc/s, i.e., a change of 9,550 kc/s, or 955 station-channels of 10 kc/s. In many parts of the short-wave region stations are separated by 10 kc/s or less. Thus in the space on the dial occupied by one station on the medium waveband there are possibly ten stations when one switches over to the short waves.

Adding a Gramophone Pick-up

IT is desired to add a gramophone pick-up to a three-valve receiver in which an output pentode follows the detector, it being necessary to use two AF stages in order to obtain sufficient amplification for the particular type of pick-up that will be used. The query is, can the detector valve be used for gramophone reproduction without affecting its performance as a detector?



Method of converting a detector valve into an amplifier for gramophone reproduction.

This is not difficult to arrange though a few extra components will be needed. The detector valve must be converted into an amplifier for gramophone reproduction by the inclusion of a cathode bias resistance which must be shunted by a condenser of about 25 mfds. An electrolytic type can be used.

As shown in the circuit reproduced here a single pole change over switch is mounted close to the grid of the valve, and is connected so that in one position the grid is joined to the existing grid condenser and leak. The grid leak is not now joined to the earth line as hitherto, but direct to the cathode of the valve.

In the other switch position the grid is joined to one of the pick-up terminals, the other terminal being connected to the earth line. Thus in the radio position no grid bias is applied to the valve, but for gramophone reproduction the valve is biased about 1 to 1½ volts negative by the cathode resistance R2.

As in all probability the pick-up terminals will be at the back of the set the lead from the switch to the pick-up terminal should be screened. Likewise, if it is not convenient to mount the switch close to the valve-holder and several inches of connecting wire are required, the leads to the grid of the valve and to the junction of the grid condenser and leak must also be screened.

Aerial and Signal-Noise Ratio

THE user of a very sensitive receiver remarks on the relatively high background noise on all stations except the local, and feels that a set of this kind should give quieter reception. A footnote states that the aerial is in the loft.

As the local station is received satisfactorily it is hardly likely that the background noise is due to a defective valve or component, but to the fact that the signal input is unduly small from all other stations and the receiver must consequently be operating at very nearly maximum sensitivity.

In the circumstances a poor signal-to-noise ratio is probably inevitable, and we can suggest no way of improving matters save by the erection of a reasonably good outdoor aerial. This will provide a stronger signal from the more distant stations, the RF valves will be biased back further, though it is probable they were not receiving any AVC bias before, and much quieter reception will result.

Because a set has several RF stages and consequently high sensitivity, it does not follow that it can be expected to work satisfactorily with an inefficient aerial.

Its high sensitivity is admittedly a valuable feature when listening to distant stations, but some background noise will have to be tolerated.

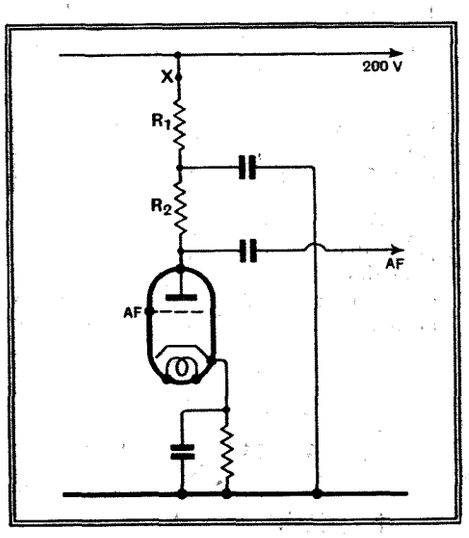
Voltage or Current Measurement

ALTHOUGH much useful information regarding the condition of a receiver can be obtained by measuring the voltage at different points in the set, there are certain conditions when this form of test will be misleading. If we take, for example, a resistance-coupled AF amplifier, as shown in the figure, and connect the voltmeter between the anode of the valve and the chassis, the meter will not give the actual voltage on the valve, but the reading so obtained will be lower than the true value.

Voltmeters consume current, the amount required for a given voltage reading being dependent on their internal resistances, and in a case of this kind dissimilar instruments would quite likely give entirely different readings.

The current taken by the meter must flow through the resistances in the anode circuit of the valve, and being additive to the valve current results in a larger voltage drop across them so that the anode voltage is reduced proportionally.

This will explain why a reader having made some measurements in his set finds that the AF valve, which is RC coupled, apparently has only 20 volts on its anode.



Typical RC coupled amplifier for which the true anode voltage is required

The low voltage readings he has obtained at the screen grids of the RF and IF valves are due to the same cause.

Apart from the use of a voltmeter having an exceptionally high internal resistance, the only other method of obtaining a true indication of anode voltage is to measure the current flowing through the circuit by inserting a milliameter at the point marked x and calculating the anode voltage.

This presupposes that one knows the values of the resistances R1 and R2, but they can usually be ascertained from their colour code markings.

If the anode current is 0.5 mA., the HT supply is 200 volts and the sum of R1 and R2 is 150,000 ohms, the true volts on the anode of the valve are 125, 75 volts being dropped by the resistances.

DEBUNKING INTERMODULATION

IT is regretted that the following explanatory line was omitted from the table in the letter under the above title by "Cathode Ray" on page 587 of last week's issue, "Fundamental: 200 c/s; 80 db above threshold (fairly loud)." In the twenty-fourth line below the table the word Harmonics should, of course, have been Harmonies.

AMATEUR CALL BOOK

THE 1938 summer edition of the Radio Amateur Call Book Magazine, which contains the call signs, names and addresses of amateur stations in all countries of the world, is now available and can be obtained from F. L. Postlethwaite, 41, Kinfauns Road, Goodmayes, Essex, the price being 6s. post free.

Random Radiations

Broadcasting and the Tests

THE broadcast commentaries on the Test matches have been quite excellent, as all those who could hear them will admit. But what about those who couldn't hear them, however much they wanted to do so? If ever there was a sporting event which called for national broadcasting it was, one would think, the playing of the national game by the national teams of this country and Australia. But owing to the wicked way in which the whole of the National programmes have been dislocated in order to provide the programmes for schools, those (and there are a good many of them) who are out of range of the Regional transmitter during the daytime could hear nothing of the happenings in the second Test Match until after 5 o'clock, except on the Saturday.

Don't Misunderstand

Don't please leap at me with the accusasion that I consider cricket of more importance than education. Of course I don't. But I do think that the duty of the B.B.C., which is, or should be, primarily a provider of entertainment, is to serve its ordinary listeners first and to consider the needs——if they are really needs—of the schools after that has been done. To me it is fantastic that though we spend far more per head on education than any other country in the world, we should have to disorganise our entire National broadcasting system on five days out of each week in school term time in order to supplement the instruction given by teachers. Many of the broadcast lessons seem to me to be matters which teachers should be perfectly competent to deal with themselves. Why, for instance, should it be necessary, or even desirable, to give broadcast lessons in church history, geography or English literature? Does the Board of Education make any contribution towards this vast service to its schools, or is it simply another of those items that the already hard-up B.B.C. has to pay for out of its barely sufficient grant?

Summer-time Loud Speakers

THE B.B.C. did well to broadcast its request to listeners to moderate the volume from their loud speakers in summer time, at all events, when windows are wide open. I wonder if you heard the recording, given as a fearful example, of what may greet the ears in some districts when different loud speakers are bellowing forth simultaneously items from Regional and National programmes, from Luxembourg, Radio Normandie, Radio-Paris and Athlone? If you didn't, you can imagine what it sounded like. And, having done that, may I beg of you to resolve not to contribute to a similar welter of loathsome noise?

Is Construction to Blame?

Sometimes I've wondered whether it isn't so much the increasing numbers of loud speakers as their actual construction which is responsible for the growing nuisance of summer-time noisiness. If you cast your mind back you'll remember that when the moving-coil loud speaker first made its appearance, those who were fond of construction vied with one another to devise methods of suspending the cone with the greatest possible amount of flexibility. But the worst of very flexible suspensions was that they were somewhat frail and the tendency in commercial loud speakers and receiving sets has been towards increased rigidity. When the cone is lightly suspended the set can be run at comparatively small volume with no loss of quality sufficient to be offensive to the ordinary ear. But the more rigidly suspended cone seems, so to speak, to take charge and to introduce its own coloration unless the volume is made pretty big. In other words, there is a very noticeable falling off in quality and an increase in woomphiness from the rigidly suspended cone at low volume levels. In self-defence the set user must turn the volume control up, and unless he is prepared to endure semi-suffocation by closing his windows, he is almost bound to annoy his near neighbours. But the stiffer suspension of loud-speaker cones may be only half the story.

By "DIALLIST"

Are We Growing Deafer?

The other half is to be found in the possibility that the hearing arrangements of those who live in the towns of to-day are becoming less sensitive. I don't know whether this is so, but I do know that the present generation doesn't seem to be able to hear comfortably unless the sounds which reach its ears are of considerably greater intensity than what was considered ample by its elders. The other day I went to a music-hall show, in the course of which every individual artist and each band or troupe made use of the microphone with its associated battery of loud speakers. To me the volume of sound so produced in the auditorium was, if not deafening, at any rate annoying and tiring. The younger people in the audience seemed to find it neither the one nor the other, but just exactly right. Perhaps, after all, their hearing is no less acute, but they find a pleasurable stimulation in sound levels that leave their elders with the feeling that they've undergone a mild form of bludgeoning!

Television from Paris

THE report that a complete programme from the Eiffel Tower television station has been received in the South of England on

Broadcast Programmes FEATURES OF THE WEEK

THURSDAY, JULY 7th.

Nat., 7, Troise and his Mandoliers. 7.30, Dave Frost and his Band. 8, "Radio Roadhouse," under the direction of Vic Oliver.

Reg., 7, Suggestions for Week-end Walks in London: 1—Charing Cross to Gray's Inn. 8, Two short plays by Walter de la Mare: "Physic" and "Miss Miller." 8.40, "You Shall Have Music"—Louis Levy and augmented B.B.C. Variety Orchestra, with Jessie Matthews. 9.30, "Bianca," musical romance.

Abroad.

Deutschlandsender, 8.10, "The Merry Wives of Windsor," opera (Nicolai).

FRIDAY, JULY 8th.

Nat., 6.25, Test Match Commentary. 7.30, "Beyond Compère," devised by Ronald Frankau. 8.15, Star Variety from Clacton. 9, "Arctic Rescue," drama by "Taffrail." 9.45, "Up Against It"—Talk by Capt. A. E. Dingle.

Reg., 6.40, Music by Heinrich Schutz. 7.55, Chess: B.B.C. *v.* Listeners. 9, Variety from Peterborough.

Abroad.

Paris PTT, 8.30, Symphony Concert from Vichy.

SATURDAY, JULY 9th.

Nat., 6.25, Test Match Commentary. 8, Variety, including Leonard Henry and Peter Dawson. 9, Swimming Commentary—speed contests at Wembley. 9.20, Old Hawaiian Songs, relayed from Honolulu. 9.40, "The Last Voyage of Captain Grant," a serial story of the Hudson Bay.

Reg., 8, "The Watched Pot," comedy. 9.15, Act II of "Cosi fan Tutte," opera (Mozart), from Glyndebourne.

Abroad.

Munich, 7.40, "Ariadne auf Naxos," opera (Richard Strauss).

Milan, 9, "Turandot," opera (Puccini).

SUNDAY, JULY 10th.

Nat., 2, London Palladium Orchestra. 4.30, Falkman and his Apache Band. 9.5, "A Voyage into Lilliput," a free adaptation of Swift's story. Cast includes Stuart Robertson and Olive Groves.

Reg., 6, Round the Courts. 9.5, Fred Hartley and his Sextet, with Billy Scott-Coomber. 9.45, Tom Jenkins and the Grand Hotel, Eastbourne, Orchestra.

Abroad.

Brussels I, 8.30, "William Tell," opera (Rossini), from Vichy.

MONDAY, JULY 11th.

Nat., 6.25, Test Match Commentary. 7, The Bungalow Club. 9, Louis Levy presents "You Shall Have Music." 9.45, "The Past Week," reviewed by the Hon. Harold Nicolson.

Reg., 6.40, Peter Sloan's Guitar Trio. 8, "Loose Box," a young man in America. 8.15, Selections from "Band Waggon." 9, Cyril Smith, pianoforte, with B.B.C. Northern Orchestra.

Abroad.

Paris PTT, 9, Calvet Quartet with Hélène Pignari, pianoforte.

TUESDAY, JULY 12th.

Nat., 6.25, Test Match Commentary. 8, "Calgary Stampede," relay from the 54th annual meeting of cowboys in Alberta, Canada. 8.30, "Great Yarmouth Nights." 9.30, "I Hear America Singing."

Reg., 8, "Horner's Corner." 8.30, Organ Recital from St. Margaret's, Westminster. 9.10, Negro Spirituals. 9.40, Speedway Racing: England *v.* Australia, at West Ham Stadium.

Abroad.

Leipzig, 7.10, Folk Songs and Dances, relayed from Dresden.

Stuttgart, 9, The Manheim Philharmonic, conducted by Rasberger.

WEDNESDAY, JULY 13th.

Nat., 7, New Homes for Old: Talk by Valentine Williams. 8, Musical Show with Jack Jackson and his Band. 9, Cyril Smith, pianoforte. 9.45, "I Was There." Commander F. G. Loring describes the collision between H.M.S. *Victoria* and H.M.S. *Camperdown.*

Reg., 6.25, Recital of English Church Music, by the B.B.C. Singers. 8.35, "Gluts in the Fruit Market," a round-table discussion. 9.45, Henry Hall and his Orchestra from the Empire Exhibition.

Abroad.

Hamburg, 7.10, Musical Episodes about a Yachting Adventure.

Vienna, 10.30, Vienna Symphony Orchestra, conducted by Kattnigg.

a Marconiphone televisor is of great interest. The instrument was apparently more or less a standard model, and no great difficulty was found in adapting it to suit the French method of transmission, which is different from ours. Nevertheless, it does seem a pity that an international standard can't be adopted, which would do away with the necessity for any such adjustments. I am rather afraid it is too late now for anything of the kind to be done, for most other countries, including the United States, have pinned their faith to 441 lines, whilst we are committed to 405 lines, interlaced, for the next three years at any rate. It may be argued that it doesn't really matter whether or not different systems are used in different countries, since DX reception of picture programmes is always something of a freak business. Wouldn't it, though, add a good deal to the attractions of television if owners of receiving sets knew that there was the off-chance of receiving programmes from abroad in specially favourable circumstances? I think, somehow, that it would.

A Big Job

BY the time that you read this the International Broadcasting Union will have come to the end of the meeting which was called to consider the broad lines to be adopted for redrafting the distribution of European wavelengths in view of the decisions of the Cairo Conference.

The I.B.U.'s meeting took place at Ouchy, and a very jolly place it is for any sort of fixture so long as you don't get that horrible wind, the bise, which is apt to come tearing down the valleys at this time of the year and to make the usually peaceful Lake of Geneva rage like the sea on a rough day. I trust that the meeting was not marred by bises or breezes either out of doors or in the conference hall, and that, invigorated by the bracing Swiss climate, they were able to get under way with plans for what promises to be the most difficult reallocation of wavelengths ever undertaken.

S.B. the Solution?

The problem to be tackled is really insoluble. That is to say, no completely satisfactory solution can possibly be found. Even with the additional wavelengths that have been granted, the available medium-wave and long-wave channels are far too few to meet all demands. Compromises galore will have to be made, and I expect that the merits of simultaneous broadcasting by synchronised stations will be strongly stressed by harassed chairmen in their endeavours to make this country or that moderate its demands for channels. There is no doubt that S.B. could be used much more widely than it is with considerable advantages to all concerned. In several countries the same programme is broadcast from numerous stations which are linked up by telephone lines but not synchronised.

New Problems

Several problems which hadn't cropped up when previous wavelength plans were drawn up are going to give the coming conference more than a spot of bother. One of these is the "Luxembourg Effect," which causes a powerful long-wave station to come in as a background to a station near the top of the medium-wave band if the two are more or less in a straight line with the receiving aerial. We know that the effect isn't confined to Luxembourg, for Droitwich also produces it, and so, presumably, do other giants like Moscow, Motala and Warsaw. France's new Radio National may be a nuisance in this way in a good many countries, including our own, when it comes into being. Next, there's long-range interference when attempts are made to make two widely separated stations use the same wavelength. The authors of the Lucerne Plan little thought that Cairo was going to upset Brussels No. 1, though it certainly does so. The interference caused by harmonics from long-wave stations with those on the medium-wave band is a matter that will have to be tackled firmly, and the downward extension of the medium-wave band means that it will become more important to prevent harmonics from stations on wavelengths down to 308 metres or even below.

News from the Clubs

Bootle and District Amateur Transmitting Society

Hon. Sec.: Mr. C. E. Cunliffe, 368, Stanley Road, Bootle, Liverpool, 20.

The club is starting a beginners' course in radio transmitting, the programme of lectures being as follows:

July 12th: "Modulation Systems," by Mr. R. D. Mackenzie.

July 19th: "Power Supplies," by Mr. T. H. Smee.

Recent lectures in connection with transmitting have been given by Messrs. C. E. Cunliffe and W. Lawson.

West Sussex Short-wave and Television Club

Headquarters: East Ashling, Near Chichester.
Meetings: Wednesdays at 8 p.m.
Hon. Sec.: Mr. C. J. Rockall, Aubretia, Seafield Road, Rustington.

On May 11th a lecture was given by a representative of The Weston Electrical Instruments Co. On June 16th Mr. Hansford, Jnr., gave a demonstration of his home-built television receiver and lectured on the fundamental principles of television.

Dollis Hill Radio Communication Society

Headquarters: Braintcroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

A 5-metre DF contest was held in the Hatfield neighbourhood on June 19th. Only one party failed to locate the hidden transmitter. The party obtaining the most accurate bearings used a loop aerial based on the design of one published in *The Wireless World*.

Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

A junk sale was held on June 13th, 25 per cent. of the money raised going to the Society's funds. Mr. T. G. R. Dowsett presented some books and magazines to the Society, and it was decided to start a library.

Irish Amateur Radio Society

Headquarters: 18, St. David's Terrace, North Circular Road, Dublin.
Hon. Sec.: Mr. J. Butler, 92, South Circular Road, Portobello, Dublin.

At a general meeting of the National Radio Society held in Dublin on June 1st the following motion was unanimously passed: "That in view of the general dissatisfaction expressed about the methods by which the National Radio Society was being run, all connection with it should be severed and the Society reformed under the name of The Irish Amateur Radio Society."

The Secretary will be pleased to send full particulars of the I.A.R.S. on receipt of a stamped envelope.

SUFFRAGETTES DEMONSTRATE

EXCITING SCENES OUTSIDE BUCKINGHAM PALACE

MANY ARRESTS

..that was in 1906!

An eventful year? Surely! Suffragettes demonstrating—fighting—chaining themselves to railings—pouring acid into pillar boxes—in militant pursuit of their cause. Yes, 1906 was, undoubtedly a year of events—both big and small. Among the lesser happenings of 1906 was the founding of T.C.C.—lesser only in that, then, T.C.C. was little-known. Yet the founding of T.C.C. was significant. It foreshadowed the coming of the reliable radio receiver of to-day. For then, as now, T.C.C. put reliability first. And in this policy, T.C.C. were right. 32 years of success have proved it. T.C.C.'s policy remains unchanged—reliability first.

T.C.C.
ALL-BRITISH
CONDENSERS

THE TELEGRAPH CONDENSER CO. LTD.
WALES FARM RD. NORTH ACTON, W.3

5163

Recent Inventions

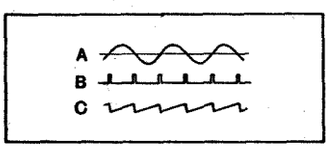
The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Build[illegible] ondon, W.C.2, price 1/- each. A selection o[illegible] pate[illegible] ed in U.S.A. is also included.

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

TIME-BASE CIRCUITS

SAW-TOOTHED voltages as used for television scanning are generated by feeding the sine-wave output A from a dynatron or other valve oscillator to the two deflecting plates of a miniature cathode-ray tube. This "sweeps" the electron stream of the tube across two slotted-disc electrodes, and so produces a series of narrow square-topped impulses B in the external circuit of the tube, the sharp rise of each impulse coinciding with the "zeros" of curve A.

The impulses B are then applied to the grid of an ordinary time-base valve, which converts them into the saw-toothed form shown at C. The form of the curve C is stated to be independent of the presence of harmonics in the original sine curve A, whilst the vertical or "flyback" stroke is restricted to not more than one-tenth the total "sweep" time. The arrangement is capable of operating over a wide frequency range.



Showing the stages in converting a sine-wave oscillation into a saw-tooth waveform.

Marconi's Wireless Telegraph Co., Ltd., and D. J. Fewings. Application date, July 21st, 1936. No. 483545.

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SUPERHET SETS

THE local-oscillator valve of a superhet set is back-coupled in different ways, as the set is switched over to receive different wavebands, the conversion from one type of back-coupling circuit to another being controlled automatically by the wave-change switch. The feed-back coils used for short-wave reception are left permanently in circuit, since their inductance is too small to have any appreciable effect on the longer waves. But on other settings of the waveband switch the superfluous coils are automatically short-circuited in order to avoid dead-end losses. The arrangement is designed to keep the local-oscillator frequency stable, over the entire frequency range of an all-wave receiver.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.) March 11th, 1936. No. 481339.

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UNDER-WATER TELEVISION

A TELEVISION set consists of a transmitter and receiver connected together by flexible cables through which the necessary operating voltages and currents are conveyed to the distant transmitter from the receiver. This allows the transmitter to be lowered through the sea, say, from a salvage boat on the surface, to survey a sunken ship, or other object at a depth lower than a diver can descend, or to make a preliminary survey before the diver goes down.

The arrangement also makes it possible to perform salvage work, without the help of a diver, by means of gripping tools or the like lowered from the ship and operated by the crew.

Similarly, the transmitter could be floated up from a submerged submarine to the surface, and used for making observations in place of a periscope. Or again the transmitter could be lowered from an aeroplane flying above the clouds to survey the terrain below.

G. Sylven. Convention date (Sweden), July 28th, 1936. No. 482835.

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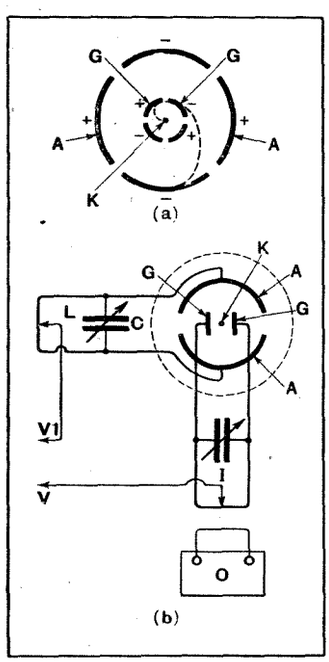
SHORT-WAVE VALVES

THE electrodes A, G, as shown in Figure (a), of a valve of the magnetron type are arranged in pairs parellel to the cathode K which lies along the axis of the valve. They are set at different radial distances from the cathode, so as to form an inner and an outer system, which are biased positively and negatively, as shown. As a result of the combined action of the electrostatic field across the electrodes and the magnetic field (which is applied from an external winding) parallel to the cathode, the electrons liberated from the latter follow a spiral path such as that shown in dotted lines, having a length determined by the applied "control" fields. The tube though having special advantages for ultra-short-wave working is not necessarily so restricted, but can be used generally as amplifier, generator, rectifier, or relay.



Electrode arrangement in the magnetron valve described in the text is shown at (a), while (b) is a modified form intended for use as an amplifier.

Figure (b) shows a simplified form for use as an amplifier. The two inner electrodes G, set parallel to the cathode K, are connected across an input circuit I which may be coupled to an oscillator O. The output is taken from the two outer electrodes A, which are branched across a tuned circuit L, C and coupled to any desired load. The biasing potentials are applied at V and V1.

Telefunken Ges. fur drahtlose Telegraphie m.b.H. Convention date (Germany), October 22nd, 1935 No. 483336.

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TELEVISION SYSTEMS

RELATES to means for transferring to a television receiver the direct-current component due to gradual variations in the background illumination of the picture as a whole. These DC variations, though present at the output of the transmitter, are usually lost by the inability of the amplifying stages to handle them.

According to the invention, the steady component — representing the "average" tone-value over given periods—is radiated in the form of a series of impulses which are produced as the result of periodically interrupting the scanning of the transmitter. These are applied, at the receiver, to control a triggered valve so as to release corresponding pulses of direct current, which are then applied to regulate the average "background" intensity of the picture shown on the fluorescent screen.

Electrical Research Products, Inc. Convention date (U.S.A.) September 2nd, 1936. No. 483451.

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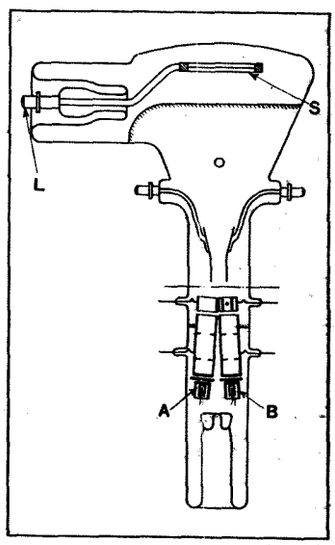
INCANDESCENT PICTURES

IN the "projection" type of television receiver, the picture is shown not by the usual fluorescent glow, but in the red and white heat of incandescence which is created as the result of bombarding an extremely thin metal screen by the scanning stream of electrons. Although producing a more intense light—so that the picture can be enlarged very considerably by optical means before it is projected for viewing—the metal screen naturally possesses a certain amount of thermal inertia. This in turn calls for high operating voltages in order to overcome any "lag" effect, especially in high-speed scanning.

According to the invention, the energy to be supplied from the scanning stream is reduced by deliberately maintaining the metal screen at a high temperature—just below that at which it begins to glow—during the intervals between successive scannings. As shown in the Figure, the incandescent screen S is subjected to the action of two separate electron streams. That from the gun A is modulated by the incoming signals and reproduces the picture by incandescence, whilst that from the gun B is not modulated, but merely serves by its bombardment to maintain the screen at a critical temperature just below the "glow point." A preliminary heating current may also be supplied to the screen through leads L from a local battery or other source.



Details of assembly of projection-type CR tube in which the picture is produced by incandescent light.

N. V. Philips Gloeilampenfabrieken. Convention date (Holland), October 24th, 1936. No. 483541.

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"PROJECTION" TUBES

INSTEAD of reproducing a televised picture by fluorescent light, it is possible to use a screen which incandesces under the action of the electron stream so as to show a "glowing" picture. The difficulty is, of course, to produce a screen sufficiently sensitive to show white or red hot momentarily, i.e., at the point under bombardment by the electron stream, without retaining the "local" temperature too long to give a clear-cut picture at cinematographic speed. At the same time the local temperature must not be allowed to "spread," because this would widen the effective scanning line.

The required conditions are secured by using a screen of tantalum not more than 6 microns thick. This is "checkerboarded" by lines of small perforations which, in effect, divide the screen into a mosaic of small squares "bordered" or separated from each other by lines of perforation. The size of each square coincides with the width of a scanning line.

N. V. Philips Gloeilampenfabrieken. Convention date (Germany), October 23rd, 1936. No. 482704.

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Ankara (Turkey)	152		1973.5	5
Kaunas (Lithuania)	153		1961	7
Hilversum (No. 1) (Holland)	160		1875	10-150
Radio Romania (Romania)	160		1875	150
Lahti (Finland)	166		1807	150
Moscow (No. 1) (U.S.S.R.)	172		1744	500
Paris (Radio Paris) (France)	182		1648	80
Istanbul (Turkey)	185		1622	5
Irkutsk (U.S.S.R.)	187.5		1600	20
Deutschlandsender (Germany)	191		1571	60
National (Droitwich)	200		1500	150
Minsk (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	16
Motala (Sweden)	216		1389	150
Novosibirsk (U.S.S.R.)	217.5		1379	100
Warsaw (No. 1) (Poland)	224		1339	120
Luxembourg	232		1293	150
Moscow (No. 2) (U.S.S.R.)	232		1293	100
Kalundborg (Denmark)	240		1250	60
Kiev (No. 1) (U.S.S.R.)	248		1209.6	100
Tashkent (U.S.S.R.)	256.4		1170	25
Bergen (Norway)	260		1153.8	20
Oslo (Norway)	260		1153.8	60
Vigra (Aalesund) (Norway)	260		1153.8	10
Leningrad (No. 1) (U.S.S.R.)	271		1107	100
Tromsö (Norway)	282		1065	10
Tiflis (U.S.S.R.)	283		1060	35
Moscow (No. 3) (U.S.S.R.)	300		1000	100
Saratov (U.S.S.R.)	340		882.3	20
Finmark (Norway)	347		864	10
Archangel (U.S.S.R.)	350		857.1	10
Rostov-on-Don (U.S.S.R.)	355		845.1	20
Budapest (No. 2) (Hungary)	359.5		834.5	18
Sverdlovsk (U.S.S.R.)	375		800	40
Banska-Bystrica (Czechoslovakia)	392		765	15-30
Boden (Sweden)	392		765	2.5
Voronezh (U.S.S.R.)	413.5		726	10
Oulu (Uleaborg) (Finland)	431		696	10
Ljubljana (Yugoslavia)	527		569.3	6.3
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	10
Wilno (Poland)	536		559.7	50
Budapest (No. 1) (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Radio Eireann (Ireland)	565		531	100
Klaipeda (Lithuania)	565		531	10
Palermo (Italy)	565		531	3
Stuttgart (Germany)	574		522.6	100
Alpes-Grenoble, (P.T.T.) (France)	583		514.6	20
Madona (Latvia)	583		514.6	50
Vienna (No. 1) (Germany)	592		506.8	100
Athens (Greece)	601		499.2	15
Rabat (Morocco)	601		499.2	20
Sundsvall (Sweden)	601		499.2	10
Florence (No. 1) (Italy)	610		491.8	20
Brussels (No. 1) (Belgium)	620		483.9	15
Cairo (No. 1) (Egypt)	620		483.9	20
Kouibyshev (U.S.S.R.)	625		480	10
Christiansand (Norway)	629		476.9	20
Lisbon (Portugal)	629		476.9	20
Tröndelag (Norway)	629		476.9	20
Prague (No. 1) (Czechoslovakia)	638		470.2	120
Lyons (P.T.T.) (France)	648		463	100
Petrozavodsk (U.S.S.R.)	648		463	10
Cologne (Germany)	658		455.9	100
Jerusalem (Palestine)	668		449.1	20
North Regional (Slaithwaite)	668		449.1	70
Sottens (Switzerland)	677		443.1	100
Belgrade (Yugoslavia)	686		437.3	20
Paris (P.T.T.) (France)	695		431.7	120
Stockholm (Sweden)	704		426.1	55
Rome (No. 1) (Italy)	713		420.8	100
Hilversum (Jaarsveld) (Holland)	722		415.4	17
Kharkov, (No. 1) (U.S.S.R.)	722		415.4	10
Madrid (EAJ2) (Spain)	731		410.4	3
Seville (EAJ5) (Spain)	731		410.4	5.5
Tallinn (Estonia)	731		410.4	20
Munich (Germany)	740		405.4	100
Marseilles (P.T.T.) (France)	749		400.5	100
Katowice (Poland)	758		395.8	12
Scottish Regional (Burghead)	767		391.1	60
Scottish Regional (Westerglen)	767		391.1	70
Stalino (U.S.S.R.)	776		386.6	10
Toulouse (P.T.T.) (France)	776		386.6	120
Leipzig (Germany)	785		382.2	120
Barcelona (EAJ1) (Spain)	795		377.4	7.5
Lwów (Poland)	795		377.4	50
Welsh Regional (Penmon) (Anglesey)	804		373.1	5
Welsh Regional (Washford)	804		373.1	70
Milan (No. 1) (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Bodö (Norway)	823		364.5	10
Stavanger (Norway)	832		360.6	10
Kiev (No. 2) (U.S.S.R.)	832		360.6	35
Berlin (Germany)	841		356.7	100
Sofia (Bulgaria)	850		352.9	100
Valencia (Spain)	850		352.9	3
Simferopol (U.S.S.R.)	859		349.2	10
Strasbourg (France)	859		349.2	100
Poznań (Poland)	868		345.6	16
London Regional (Brookmans Park)	877		342.1	70
Graz (Germany)	886		338.6	15
Linz (Germany)	886		338.6	15
Helsinki (Finland)	895		335.2	10
Hamburg (Germany)	904		331.9	100
Dniepropetrovsk (U.S.S.R.)	913		328.6	10
Toulouse (Radio Toulouse) (France)	913		328.6	60
Brno (Czechoslovakia)	922		325.4	32
Brussels (No. 2) (Belgium)	932		321.9	15
Algiers (Algeria)	941		318.8	12
Göteborg (Sweden)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Odessa (U.S.S.R.)	968		309.9	10
Northern Ireland Regional (Lisnagarvey)	977		307.1	100
Bologna (Radio Marconi) (Italy)	986		304.3	50
Torun (Poland)	986		304.3	60
Hilversum (No. 2) (Holland)	995		301.5	10-60
Bratislava (Czechoslovakia)	1004		298.8	13.5
Chernigov (U.S.S.R.)	1013		296.2	4
Midland Regional (Droitwich)	1013		296.2	70
Barcelona (EAJ15) (Spain)	1022		293.5	3
Königsberg (No. 1) (Heilsberg) (Germany)	1031		291	100
Parede (Portugal)	1031		291	5
Leningrad (No. 2) (U.S.S.R.)	1040		288.5	10
Rennes-Bretagne (France)	1040		288.5	120
West of England Regional (Washford)	1050		285.7	50
Bari (No. 1) (Italy)	1059		283.3	20
Paris (Radio Cité) (France)	1068		280.9	2
Tiraspol (U.S.S.R.)	1068		280.9	10
Bordeaux-Lafayette (France)	1077		278.6	60
Madrid (EAJ7) (Spain)	1095		274	5
Vinnitsa (U.S.S.R.)	1095		274	10
Kuldiga (Latvia)	1104		271.7	25
Naples (Italy)	1104		271.7	10
Melnik (Czechoslovakia)	1113		269.5	100
Nyiregyhaza (Hungary)	1113		269.5	6.25
North-East Regional (Stagshaw)	1122		267.4	60
Hörby (Sweden)	1131		265.3	60-100
Genoa (No. 1) (Italy)	1140		263.2	10
Trieste (Italy)	1140		263.2	10
Turin (No. 1) (Italy)	1140		263.2	7
London National (Brookmans Park)	1149		261.1	20
North National (Slaithwaite)	1149		261.1	20
Scottish National (Westerglen)	1149		261.1	50
Košice (Czechoslovakia)	1158		259.1	10
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark)	1176		255.1	10
Nice-Côte d'Azur (France)	1185		253.2	60
Coblenz (Germany)	1195		251	2
Frankfurt (Germany)	1195		251	25
Freiburg (Germany)	1195		251	5
Trier (Germany)	1195		251	2
Moravská-Ostrava (Czechoslovakia)	1204		249.2	5
Lille (Radio P.T.T. Nord) (France)	1213		247.3	60
Rome (No. 2) (Italy)	1222		245.5	60
Gleiwitz (Germany)	1231		243.7	5
Görlitz (Germany)	1231		243.7	5
Cork (Ireland)	1235		242.9	1
Saarbrücken (Germany)	1249		240.2	17
Riga (Latvia)	1258		238.5	15
Burgos (Spain)	1258		238.5	20
Nürnberg (Germany)	1267		236.8	2
Radio Mediterranée (France)	1276		235.1	27
Aberdeen	1285		233.5	1
Klagenfurt (Germany)	1294		231.8	5
Vorarlberg (Germany)	1294		231.8	5
Malmö (Sweden)	1312		228.7	2.5
Bremen (Germany)	1330		225.6	2
Flensburg (Germany)	1330		225.6	2
Hanover (Germany)	1330		225.6	2
Stettin (Germany)	1330		225.6	2
Dublin (Ireland)	1348		222.6	0.5
Genoa (No. 2) (Italy)	1357		221.1	5
Milan (No. 2) (Italy)	1357		221.1	4
Warsaw (No. 2) (Poland)	1384		216.8	7
Lyons (Radio Lyons) (France)	1393		215.4	25
Radio Normandie (Fécamp) (France)	1411		212.6	15
Vaasa (Finland)	1420		211.3	10
Kaiserlautern (Germany)	1429		209.9	2.5
Paris (Eiffel Tower) (France)	1456		206	7
Bournemouth	1474		203.5	1
Plymouth	1474		203.5	0.3

SHORT-WAVE STATIONS OF THE WORLD

Arranged in Order of Frequency and Wavelength (Stations with an Aerial Power of 20 kW. and above in heavy type)

Station.	Call Sign.	mc/s.	Tuning Positions.	Metres.	kW.
Bombay (India)	VUB2	4.90		61.00	10
Delhi (India)	VUD2	4.99		60.06	10
Bandoeng (Java)	PMY	5.15		58.30	1
Caracas (Venezuela)	YV5RC	5.80		51.72	1
Vatican City (Vatican State)	HVJ	5.97		50.26	15
Mexico City (Mexico)	XEBT	6.00		50.00	1
Pretoria (South Africa)	ZRH	6.00		49.96	7
Montreal (Canada)	CFCX	6.00		49.96	0.1
Montevideo (Uruguay)	CXA2	6.00		49.96	5
Havana (Cuba)	COCO	6.01		49.92	2.5
Podebrady (Prague) (Czechoslovakia)	**OLR2A**	6.01		49.92	30
Sydney (Canada)	CJCX	6.01		49.92	1
Zeesen (Germany)	**DJC**	6.02		49.83	5–40
Podebrady (Prague) (Czechoslovakia)	**OLR2B**	6.03		49.75	30
Boston (U.S.A.)	**W1XAL**	6.04		49.67	20
Miami (U.S.A.)	W4XB	6.04		49.67	5
Daventry (Gt. Britain)	**GSA**	6.05		49.59	10–50
Cincinnati (U.S.A.)	W8XAL	6.06		49.50	10
Philadelphia (U.S.A.)	W3XAU	6.06		49.50	10
Motala (Sweden)	SBO	6.06		49.46	0.75
Georgetown (British Guiana)	VP3MR	6.07		49.42	0.2
Chicago (U.S.A.)	W9XAA	6.08		49.34	0.5
Nairobi (Kenya)	VQ7LO	6.08		49.33	0.5
Lima (Peru)	OAX4Z	6.08		49.33	15
Toronto (Canada)	CFRX	6.09		49.28	0.5
Hong Kong (China)	ZBW2	6.09		49.26	2.5
Capetown (South Africa)	ZRK	6.10		49.20	5
Johannesburg (South Africa)	ZRJ	6.10		49.20	0.1
Bound Brook (U.S.A.)	**W3XAL**	6.10		49.18	15–35
Chicago (U.S.A.)	W9XF	6.10		49.18	10
Belgrade (Yugoslavia)	YUA	6.10		49.18	1
Daventry (Gt. Britain)	**GSL**	6.11		49.10	10–50
Calcutta (India)	VUC	6.11		49.10	0.5
Wayne (U.S.A.)	W2XE	6.12		49.02	10
Montevideo (Uruguay)	CXA4	6.12		49.98	1
Jelöy (Norway)	LKJ	6.13		48.94	1
Havana (Cuba)	COCD	6.13		48.92	1
Halifax (Canada)	VE9HX	6.13		48.90	0.5
Pittsburgh (U.S.A.)	**W8XK**	6.14		48.83	28
Durban (South Africa)	ZRD	6.15		48.80	0.01
Winnipeg (Canada)	CJRO	6.15		48.78	2
San Jose (Costa Rica)	TIPG	6.41		46.80	2
Riobamba (Ecuador)	PRADO	6.61		45.31	2
Radio-Nations (Switzerland)	**HBQ**	6.67		44.94	20
Amateurs		7.00 to 7.30		42.86 to 41.10	0.01
Barcelona (Spain)	EAJ1	7.03		42.70	—
Burgos (Spain)	EA1BO	7.50		40.00	—
Radio-Nations (Switzerland)	**HBP**	7.80		38.48	20
Sofia (Bulgaria)	LZA	8.46		35.44	1.5
Budapest (Hungary)	HAT4	9.12		32.88	6
Havana (Cuba)	COCH	9.43		31.80	1
Madrid (Spain)	EAR	9.49		31.62	10
Rio de Janeiro (Brazil)	PRF5	9.50		31.58	12
Melbourne (Australia)	VK3ME	9.50		31.58	5
Bangkok (Siam)	HS8PJ	9.50		31.58	5
Mexico City (Mexico)	XEWW	9.50		31.58	10
Lahti (Finland)	—	9.50		31.58	1
Daventry (Gt. Britain)	**GSB**	9.51		31.55	10–50
Montevideo (Uruguay)	CXA8	9.51		31.55	2.5
Skamlebaek (Denmark)	OZF	9.52		31.51	6
Paris (Radio-Mondial) (France)	**TPB11**	9.52		31.51	25
Pretoria (South Africa)	ZRH	9.52		31.50	7
Hong Kong (China)	ZBW3	9.52		31.49	2.5
Jelöy (Norway)	LKC	9.53		31.48	1
Schenectady (U.S.A.)	**W2XAF**	9.53		31.48	25
Suva (Fiji Islands)	VPD2	9.53		31.47	0.4
Tokio (Japan)	**JZI**	9.54		31.46	50
Zeesen (Germany)	**DJN**	9.54		31.45	5–40
Podebrady (Prague) (Czechoslovakia)	**OLR3A**	9.55		31.41	30
Bombay (India)	VUB2	9.55		31.41	10
Schenectady (U.S.A.)	W2XAD	9.55		31.40	18
Sourabaya (Java)	YDB	9.55		31.40	1
Zeesen (Germany)	**DJA**	9.56		31.38	5–40
Lima (Peru)	OAX4T	9.56		31.37	10
Millis (U.S.A.)	W1XK	9.57		31.35	10
Manila (Philippine Isles)	KZRM	9.57		31.35	1
Daventry (Gt. Britain)	**GSC**	9.58		31.32	10–50
Lyndhurst (Australia)	VLR	9.58		31.32	1
Philadelphia (U.S.A.)	W3XAU	9.59		31.28	10
Sydney (Australia)	**VK2ME**	9.59		31.28	20
Perth (Australia)	VK6ME	9.59		31.28	2
Huizen (Holland)	**PCJ**	9.59		31.28	60
Delhi No. 2 (India)	VUD2	9.59		31.28	10
Moscow (U.S.S.R.)	**RW96**	9.60		31.25	20
Capetown (South Africa)	ZRK	9.60		31.25	7
Sourabaya (Java)	YDB	9.61		31.20	1
Rome (Italy)	**12RO3**	9.63		31.13	25
Lisbon (Portugal)	CS2WA	9.65		31.09	2
Buenos Aires (Argentine Republic)	LRX	9.66		31.06	10
Guatemala City (Guatemala)	TGWA	9.68		30.97	—
Havana (Cuba)	COCQ	9.74		30.08	1
Lisbon (Portugal)	CSW3	9.74		30.08	5
Havana (Cuba)	COCM	9.83		30.51	1
Madrid (Spain)	**EAQ**	9.86		30.43	20
Marapicú (Brazil)	PSH	10.22		29.35	12
Bandoeng (Java)	PMN	10.26		29.24	1.5
Ruysselede (Belgium)	ORK	10.33		29.04	9
Buenos Aires (Argentine Republic)	LSX	10.35		28.99	12
Burgos (Spain)	EA1BO	10.37		28.93	—
Taihoku (Japan)	JIB	10.53		28.48	10
Bandoeng (Java)	PLP	11.00		27.27	1.5
Lisbon (Portugal)	CSW2	11.04		27.17	5
Radio-Nations (Switzerland)	**HBO**	11.40		26.31	20
Warsaw (Poland)	**SPD**	11.53		26.01	20
Motala (Sweden)	SBP	11.70		25.63	0.75
Santiago (Chile)	CB1170	11.70		25.63	—
Winnipeg (Canada)	CJRX	11.72		25.60	2
Paris (Radio-Mondial) (France)	TPA4	11.72		25.60	12
Huizen (Holland)	**PHI**	11.73		25.57	25
Boston (U.S.A.)	**W1XAL**	11.73		25.57	20
Havana (Cuba)	COCX	11.74		25.55	1
Daventry (Gt. Britain)	**GSD**	11.75		25.53	10–50
Podebrady (Prague) (Czechoslovakia)	**OLR4B**	11.76		25.51	30
Zeesen (Germany)	**DJD**	11.77		25.49	5–40
Lahti (Finland)	—	11.78		25.47	1
Boston (U.S.A.)	**W1XAL**	11.79		25.45	20
Tokio (Japan)	**JZJ**	11.80		25.42	50
Zeesen (Germany)	**DJO**	11.80		25.42	5–40
Vienna (Germany)	OER3	11.80		25.42	1.5
Rome (Italy)	**12RO4**	11.81		25.40	25
Daventry (Gt. Britain)	**GSN**	11.82		25.38	10–50
Wayne (U.S.A.)	W2XE	11.83		25.36	10
Lisbon (Portugal)	CWS4	11.84		25.34	5
Podebrady (Prague) (Czechoslovakia)	**OLR4A**	11.84		25.34	30
Zeesen (Germany)	**DJP**	11.85		25.31	5–40
Daventry (Gt. Britain)	**GSE**	11.86		25.29	10–50
Pittsburgh (U.S.A.)	**W8XK**	11.87		25.26	24
Paris (Radio-Mondial) (France)	**TPB7**	11.88		25.24	25
Paris (Radio-Mondial) (France)	TPA3	11.90		25.21	12
Moscow (U.S.S.R.)	**VZSPS**	12.00		25.00	20
Reykjavik (Iceland)	TFJ	12.23		24.52	7.5
Warsaw (Poland)	SPW	13.63		22.00	2
Amateurs		14.00 to 14.40		21.42 to 20.84	0.01
Barcelona (Spain)	EAJ1	14.06		21.35	—
Radio-Nations (Switzerland)	**HBJ**	14.53		20.64	20
Moscow (U.S.S.R.)	**RKI**	15.08		19.89	25
Zeesen (Germany)	**DJL**	15.11		19.85	5–40
Vatican City (Vatican State)	**HVJ**	15.12		19.84	25
Paris (Radio-Mondial) (France)	**TPB6**	15.13		19.83	25
Boston (U.S.A.)	**W1XAL**	15.13		19.83	20
Daventry (Gt. Britain)	**GSF**	15.14		19.82	10–50
Bandoeng (Java)	YDC	15.15		19.80	1.5
Tokio (Japan)	**JZK**	15.16		19.79	50
Guatemala City (Guatemala)	TGWA	15.17		19.78	—
Skamlebaek (Denmark)	OZH	15.17		19.78	6
Daventry (Gt. Britain)	**GSO**	15.18		19.76	10–50
Hong Kong (China)	ZBW4	15.19		19.75	2.5
Lahti (Finland)	—	15.19		19.75	1
Zeesen (Germany)	**DJB**	15.20		19.74	5–40
Pittsburgh (U.S.A.)	W8XK	15.21		19.72	18
Huizen (Holland)	**PCJ2**	15.22		19.71	60
Paris (Radio-Mondial) (France)	TPA2	15.24		19.68	12
Boston (U.S.A.)	**W1XAL**	15.25		19.67	20
Daventry (Gt. Britain)	**GSI**	15.26		19.66	10–50
Wayne (U.S.A.)	W2XE	15.27		19.65	10
Zeesen (Germany)	**DJQ**	15.28		19.63	5–40
Buenos Aires (Argentine Republic)	LRU	15.29		19.62	7
Daventry (Gt. Britain)	**GSP**	15.31		19.60	10–50
Schenectady (U.S.A.)	W2XAD	15.33		19.57	18
Zeesen (Germany)	**DJR**	15.34		19.56	5–40
Budapest (Szekesfehervar) (Hungary)	HAS3	15.37		19.52	6
Hicksville (U.S.A.)	W2XGB	17.31		17.33	5
Hong Kong (China)	ZBW5	17.75		16.90	2.5
Zeesen (Germany)	**DJE**	17.76		16.89	5–40
Wayne (U.S.A.)	W2XE	17.76		16.89	10
Paris (Radio-Mondial) (France)	**TPB3**	17.76		16.88	25
Huizen (Holland)	**PHI2**	17.77		16.87	25
Bound Brook (U.S.A.)	**W3XAL**	17.78		16.87	15–35
Daventry (Gt. Britain)	**GSG**	17.79		16.86	10–50
Buenos Aires (Argentine Republic)	LSY3	18.11		16.56	5
Radio-Nations (Switzerland)	**HBH**	18.48		16.23	20
Bangkok (Siam)	HS8PJ	19.02		15.77	5
Zeesen (Germany)	**DJS**	21.45		13.99	5–40
Daventry (Gt. Britain)	**GSH**	21.47		13.97	10–50
Schenectady (U.S.A.)	W2XAD	21.50		13.95	18
Wayne (U.S.A.)	W2XE	21.52		13.94	10
Daventry (Gt. Britain)	**GSJ**	21.53		13.93	10–50
Pittsburgh (U.S.A.)	W8XK	21.54		13.93	6
Daventry (Gt. Britain)	**GST**	21.55		13.92	10–50

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EDITORIAL COMMENT

Television

Making Propaganda Effective

WE recently discussed the matter of the slowness of the general public to take a practical interest in television to the extent of purchasing sets. We know that the public interest is there in theory because of the very good attendances which demonstrations enjoy, but these do not seem to result in sales of sets. Unfortunately, perhaps, the success of television must be measured in terms of the number of sets the public buys and the further development of the service also depends upon the same thing.

As a result of our recent discussion we have had a large number of letters from those who have evidently studied the position carefully and our analysis of their comments leads us to the conclusion that the one factor which retards the commercial progress of television in terms of the number of sets sold is uncertainty on the part of the public as to the finality of the receiver designs. The public seems to anticipate constant modifications and improvements in the receivers as time goes on and price variations with equal frequency.

Manufacturers' Responsibility

If this truly represents the position then the remedy must lie in the hands of the manufacturers. If some form of standardisation of receivers by manufacturers over a reasonable period with a fixed price over that period were announced, and some means devised of ensuring that the public was not let down by such promises being broken, much might be achieved. It almost seems that the assurance to the public should come from the Television Committee, to whom all manufacturers should pledge themselves over a period The fixing of price over a reasonable period would be very fair because there seems to us no possibility of any substantial price reduction for a long while unless performance is to suffer in a way which would discredit television for all time. Such a disaster should be guarded against at all costs.

At this stage television could be wrecked by a price competition between manufacturers, and the only way, as we see it, to achieve really economical manufacture is by some form of standardisation.

We would wish to make it clear that such a policy as we have outlined above is one which we consider only desirable in the early stages as a means of getting television going—later on freedom of individual manufacturers to compete amongst themselves on price and types of set should be resumed.

Temptation

Car Radio and the B.B.C.

HAVE the B.B.C. just now realised that a separate receiving licence is required for a car radio set ?

We ask the question because the B.B.C. are in need of additional funds. A boom in car radio might well mean another £200,000 in licence fees.

The B.B.C. have recently intimated that they no longer consider car radio a source of danger on the roads and that they will sponsor it by references in their programmes and deal with the subject in their journals too.

Yet there are still supporters for the idea that advertising programmes should be allowed as a means of increasing B.B.C. revenue and who believe that this need not prove a temptation to the B.B.C. to allow advertising to encroach " too far " !

Home Recording

INTRODUCTION TO THE DIRECT SYSTEM

By HUMFREY ANDREWES, B.Sc., A.M.I.E.E.

IN this, the first of a series of articles on home recording, the author explains the principal differences between commercial and amateur practice, then discusses the various systems that have been used and explains why the lateral method of modulation for discs is now almost universally employed.

AT the present time there is no doubt that great interest is being displayed in the directly recorded gramophone record, as it provides the amateur radio enthusiast with yet another field of experimental work, as well as enabling him to make excellent records at home not only of radio programmes, but also using a microphone, of his friends' voices.

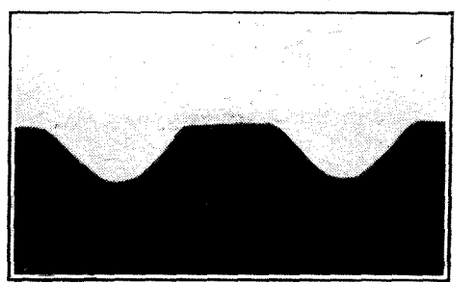
It is very desirable, however, that before commencing experimental work on any direct recording system that the amateur should familiarise himself with the principles on which the apparatus works, which he is going to use. The writer has found that there has been very little written which is available to the ordinary reader on this engrossing subject, and that much of the information which he has acquired has been obtained largely by painful and sometimes rather costly experiment. It is to be hoped, therefore, that the following notes will help anyone wishing to take up this subject and save them both time and expense in their experiments.

Commercial Recording

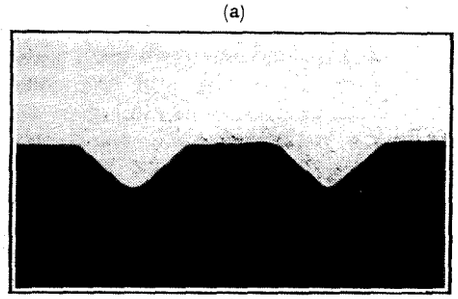
Let us first define our subject and briefly compare the direct record with the ordinary commercial disc which we buy in a shop. To understand the differences and advantages, from the experimenter's point of view, of the direct record, let us first consider the processes involved in producing the commercial disc. To produce a shellac pressing of a musical number, to take a specific example, the actual recording is made on a wax blank. This is a thick disc of suitable wax considerably larger in diameter than the final pressing. After the recording has been made this wax is covered on its recorded face with a conducting coating such as carbon, silver or bronze, and placed in an electroplating bath and a metal "skin" grown on its surface. This skin is then separated from the wax and it would be then possible, if only a few records were required, to mount it in a suitable press and produce pressings from it. This metal skin is, of course, the negative of the original recording, and is sometimes called the master matrix.

When large quantities of pressings are required, as is normally the case with a commercial recording, a second positive matrix called the mother is made by a similar electroplating process, and from this a number of stampers may be made, which are used for the actual production of pressings.

This, then, very briefly, is the process, and for further details the reader is referred to an excellent book on the subject.* Now in the case of the direct record the wax blank is replaced by a disc of material which is soft enough to cut, but not, of course, as soft as wax, and which at the same time is hard enough, or may be made hard enough by some simple process, so that it may be played at least as many times as a commercial disc without damage. The wax of the commercial process may be, and is, of course, played, in the case of a test recording, but this requires a special pick-up, and, in any case, only a few playings are possible. The advantage of the direct record is, therefore, that we may make a recording which may be played immediately after it has been made, and which can compare favourably with a commercial pressing. It also does not require a complicated process to produce such a record, and the cost is very much less than in the case of the commercial pressing unless a large quantity is required. The disadvantage of the direct system is that normally only one record is made and copies or duplicates are only produced by "dubbing," that is, re-recording, using an electrical pick-up. This latter disadvantage has been partially overcome, as it has been found possible to grow a "skin" on a directly recorded disc in a similar manner to a wax, but the production of pressings then becomes as costly as for normal wax recording, and is usually beyond the means of the experimenter.



(a)



(b)

Fig. 1.—Sectional photographs showing the different shaped grooves used for (a) commercial shellac pressings and (b) direct recordings. *Courtesy Decca Record Co.*

The Gramophone Record, by Courtnay Bryson.

Recording Systems

Having defined our subject, let us now consider the various types of direct recording that may be used. It should be emphasised at this point that there are, of course, a number of types of sound recording which have the advantage of instantaneous playback apart from the direct gramophone record, such as the steel tape and certain types of film recording, but it is not proposed to discuss or even compare these with the disc method, as it is felt that discussion would be rather outside the scope of the present articles. Probably, the earliest and certainly the most familiar type of directly recorded disc is the plain aluminium record. Home recorders using this type of disc have been available to the experimenter for a good many years, and their shortcomings have probably led a good many of my readers to the conclusion that satisfactory records which have a reasonable life can only be made on very expensive apparatus, the operation of which requires considerable skill and experience.

A few years ago this position was undoubtedly the case, but with the rapid development of the manufacture of discs and recording equipment during the last few years, systems have now become available to the experimenter which enable him to make gramophone records at home which can compare favourably with commercial recordings on apparatus which is well within his means. As an example of this the reader is referred to an article in *The Wireless World* for February 10th, 1938.

As a result of the relatively poor results which were obtained with early home recorders, and the extremely short life of the records, the plain aluminium record has been largely superseded by the coated disc, but it is possible to make quite good recordings on the plain aluminium disc if the right methods are employed, and such discs are very useful for experimental recordings which are of only momentary interest and have the great advantage of cheapness. Methods of recording on such discs will be discussed later in dealing with discs and cutting styluses.

Before coming to a detailed inspection

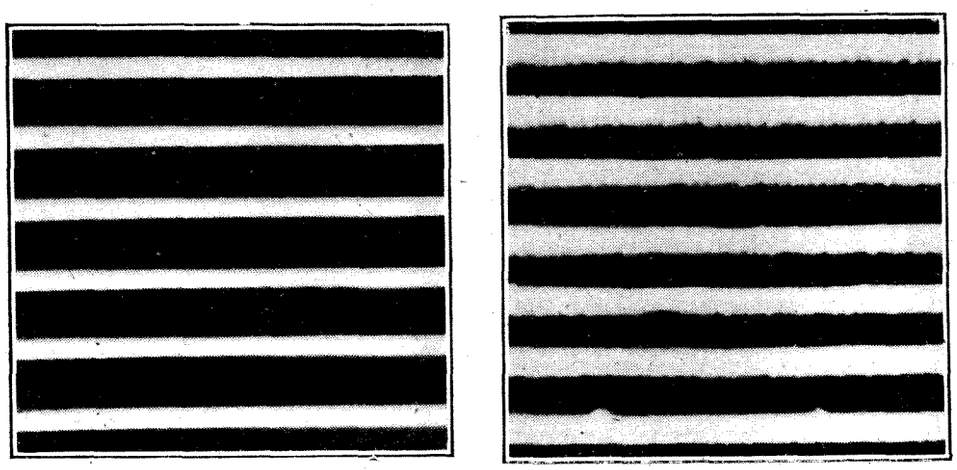
Home Recording—

of either the equipment required or the actual discs to be used in making our record, it is perhaps not out of place to consider briefly the actual principles involved. In the ordinary commercial recordings, and, for that matter, in our direct recording, the recording is produced by lateral movements of the point of the cutting stylus while it is cutting a spiral groove on the disc to be recorded. For this reason the process is generally referred to as lateral recording. In the other method of disc recording which is not normally employed the point of the stylus moves vertically up and down in the spiral groove and this method is called hill and dale recording. It is interesting to note that the original Edison phonograph worked on the hill and dale system and was essentially a direct recording.

In order to reproduce the sound from either type of recording, it is necessary for the point of the replay needle to traverse the spiral groove cut in the disc and the lateral or vertical movements of this needle produce either movements of the diaphragm of the sound box in the case of an acoustic reproducer, or in the case of an electrical pick-up a small AC voltage which may be amplified to produce the sound from a loud speaker. On theoretical and practical grounds it can be shown that the hill and dale method has distinct advantages over the lateral method, but as all commercial discs are recorded by the latter method, and as all the equipment at present available to the experimenter is also designed for use on this system, it is perhaps beyond the scope of the present article to discuss the advantages and disadvantages of the two systems beyond mentioning that with the hill and dale method the low-frequency end of the spectrum may be recorded without restriction, making reproduction very much easier, and also that the ratio of music to surface noise may be increased.

Let us, therefore, now consider the lateral system of recording in more detail. Turning first to the plain, unmodulated groove, it cannot be emphasised too strongly that in setting up any recording machine using any type of disc and cutter it is essential to cut a satisfactory unmodulated groove before attempting to make a recording. Too often the writer has found that unsatisfactory results have been due to lack of attention to this point. An important difference between wax and direct recording exists in the shape of the groove. Figure 1 (a) shows a view of the cross-section of a commercial shellac pressing and (b) that of a pressing made from a directly recorded disc; these show the comparison between the two grooves.

Although the various recording companies use differently shaped grooves, the general shape is the same, and it will be noted that the bottom of the groove of the wax recording is always rounded, whereas the direct record groove is V-shaped. This is due to the fact that it has not been found practical to cut a clean groove in the record material, which is, of course, much harder and tougher than wax, unless the cutter ends in a sharp point. We thus see that we get a groove which is triangular in cross-section, the depth being approximately equal to the width. In a normal recording where the speed of rotation of the turntable is 78 RPM and the pitch of the spiral is 100 threads to the inch, if the width of the groove is made equal to the distance between the grooves, we shall get a width of five thousandths and a depth of two and a half thousandths of an inch. In practice these dimensions are found to be the best for normal recordings. These dimensions vary, however, according to the type of record to be made as the pitch of the spiral and the speed of rotation of the turntable affect the playing time, which is an important factor.



(a) (b)

Fig. 2.—Very much enlarged views of a plain, unmodulated groove on a directly recorded disc showing (a) a good cut and (b) a bad cut. Note the rough edges of the grooves.

Disc Speed

Most direct recording machines are set for a spiral of approximately 95 threads per inch, and a practically universal speed of rotation of 78 RPM, though the reason for the choice of this particular speed has always been a complete mystery to the writer, and under these conditions we get a playing time of four to four and a half minutes for a twelve-inch record, and three to three and a quarter minutes for a ten-inch record. For some purposes these playing times are much too short, and it was for this reason that the early "talkie" records, which were used before the introduction of sound on film recording, were recorded at thirty-three and one-third revolutions per minute and were sixteen inches in diameter. These records had a playing time of about ten minutes. Other long-playing records have also been made with spiral pitches up to 250 threads per inch and speeds of rotation as low as 24 RPM. Such variations from normal commercial standards introduce practical difficulties as we shall see later, and in the early stages the experimenter is strongly advised to keep to the usual practice.

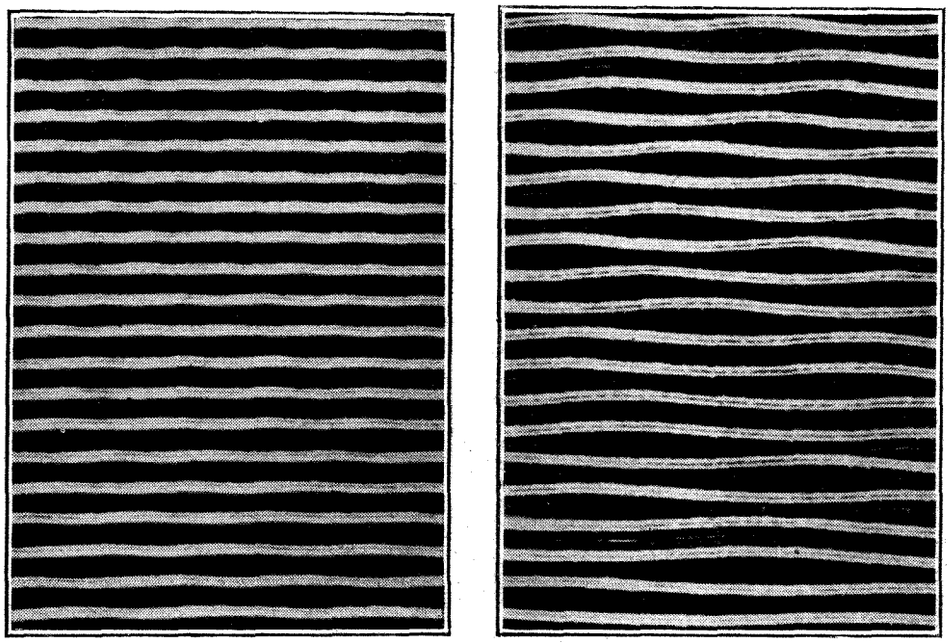
Having now considered the cutting of a simple spiral groove, we must consider the effect of some of the factors discussed above when this plain spiral is changed to a sine wave of one frequency. By means to be discussed later the point of the cutting stylus is caused to vibrate laterally at the frequency to be recorded. This point when cutting the record will then have two distinct motions relative to the disc, one due to the rotation of the disc, the speed of which is constantly decreasing as we approach the centre of the disc, and the other at right angles to the normal groove, that is to say along a radius of the disc, due to the alternating current passing through the recording head which carries the stylus. It will be seen, therefore, that as the spiral becomes smaller, as we approach the centre of the disc, the distance between successive waves of the sine wave becomes smaller and smaller, and as the point of the reproducing needle with which the record will afterwards be played, must have a finite size, when the distance between successive waves becomes smaller than the effective size of the point of the needle, the quality of reproduction, that is to say the proportion of the upper part of the frequency spectrum which is reproduced falls off as the spiral becomes smaller.

Now let us see how this affects a spiral cut on a disc having dimensions as described earlier. It is assumed to begin with that the distance between the groove centres is ten thousandths of an inch and that, therefore, the distance between the edge of one groove and the edge of the next will be five thousandths of an inch, so in order to prevent one groove running into the next we must limit the amplitude of the wave to less than five thousandths of an inch, that is less than two and a half thousandths on either side of the centre line of the groove. It has been found in practice that if this limit is imposed for the lowest frequency that it is proposed to record, and if the constant maximum velocity law is adhered to throughout the whole frequency range, the resulting record is unsatisfactory as regards the ratio of surface noise to music, and it has been found necessary in practice to arrange a compromise, the amplitude of the wave being kept constant instead of the maximum velocity of the point of the stylus, from the lowest frequency to be recorded

Home Recording—

up to approximately three to four hundred cycles per second, and the constant maximum velocity law being employed from this frequency onwards. This point will be discussed again later when we consider how this may be done practically, when we are dealing with the frequency characteristics of the recording head, as it has been found desirable in practice to introduce constant amplitude recording at the extreme upper end of the spectrum to combat the loss of the higher frequencies due to needle and disc losses. On this particular point, however, only general indications can be given as authorities vary considerably as to the exact practice to be adopted.

It may be mentioned at this point that it is not normally good practice to cut a spiral having an inside diameter of less than four inches, as the falling off in quality of reproduction inside this size is very marked, although due to the length of the item many commercial recordings may be found where the recording extends practically to the label and may play for as long as five minutes. To appreciate the falling off in the frequency response mentioned it is only necessary to reproduce the first few grooves of a good commercial recording and then immediately the last few grooves. The result is rather startling if a suitable record is chosen.



(a) (b)

Fig. 3.—Actual photographs of directly recorded gliding tone disc (a) with amplitude inversely proportional to frequency and (b) at constant amplitude.

Luckily, in practice the human ear becomes gradually accustomed to the falling frequency characteristic and the effect is not normally very noticeable, except perhaps in the case of a reproducer fitted with an automatic record changer, where the period between the end of one record and the beginning of the next is short and a continuous recording is being played.

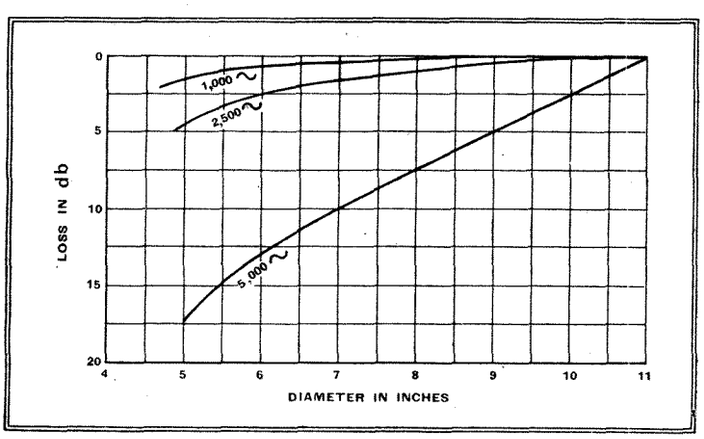


Fig. 5.—This should be studied in conjunction with Fig. 4 as it relates to the same conditions of test, but in this case for the type B disc mentioned in the text.

Before leaving the subject of reproduction quality it might be mentioned that although normal commercial recordings are always made cutting from the outside inwards, the 16in. "talkie" records referred to earlier were all recorded from the inside outwards. One reason for this was that as the quality of reproduction depends not only on the size of the spiral, but also on the size and shape of the replay needle, if a new needle is used on the inside groove where the distance between successive waves is the smallest for the high frequencies, and the needle has become worn when it reaches the outside of the spiral where the distance is the greatest, the variation in quality throughout the record and from record to record will be much less. This type of record, even if recorded at 78 RPM and of 12in. diameter, cannot be played on radiograms fitted with an automatic stop, but for the experimenter with a reproducer without this device this method of recording has distinct advantages. It also simplifies the cutting process as will be explained later. Discs of larger diameter than 12in. are now available and the frequency response may be appreciably improved by the increase in speed thereby obtainable, but unfortunately needle wear also increases with speed so that the disadvantages may outweigh the advantages.

Although it is comparatively easy to calculate approximately the loss in frequency response due to the change in the diameter of the recorded spiral, it must be remembered that the composition of the disc material also comes into our calculations, and owing to the fact that practically all discs must inevitably be softer than shellac the results will vary for different types of disc. The effect of the softer disc is that the walls of the groove are slightly elastic, and, therefore, tend to give under the pressure of the needle. There is, of course, the compensating effect, however, that on loud, heavily recorded passages the wall of the groove does not so easily break down as is the case with the shellac pressing.

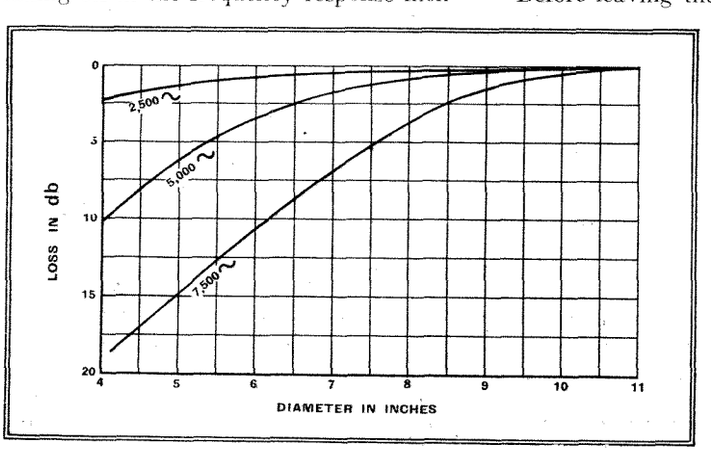


Fig. 4.—Curves showing frequency limitation with one type of directly recording disc designated type A at different distances from the centre expressed as a decibel loss compared with measurements made at the greatest diameter.

It is not out of place, therefore, to give some actual figures which the writer has obtained on two types of coated disc. To obtain the figures from which the curves shown in Figures 4 and 5 were plotted a simple sine wave, at four different frequencies, keeping the voltage constant on the recording head throughout the experiment, was recorded at different distances from the centre of the disc and using a sapphire cutting point. A band of ap-

Home Recording—
proximately an eighth of an inch was recorded in each case, and after hardening the record in a normal manner, the record was played back using a needle armature pick-up fitted with a straight steel needle. For each frequency the result is expressed as loss in decibels compared with the reading obtained at the greatest diameter so that the frequency response of the pick-up did not come into the experiment, or, of course, that of the recording head.

The curves shown are for two different type of disc, and indicate the variation that may be experienced, and it should be noted that in the case of Type A no appreciable loss was noted at 1,000 cycles, and, therefore, the curve is not shown. In the case of Type B disc there was a slight loss even at 1,000 cycles. It was found that it was not easy to get very reliable results on the highest frequency owing to variations in the needle point and other factors, but the results obtained show clearly that the loss even at 5,000 cycles is very considerable near the centre of the disc.

Foundations of Wireless. By A. L. M. Sowerby, M.Sc. (Second Edition.) Pp. 272, with 158 diagrams. Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 4s. 6d. net.

THE original edition of this book, which was reviewed in these columns two years ago (July 17th, 1936), proved very popular among serious radio amateurs, to whom it had a particular appeal insomuch that it dealt with its subject matter on a thoroughly practical basis. Several quasi-technical books have been written for the man-in-the-street desiring to imbibe a little superficial knowledge of the workings of wireless, and the original edition of this book very successfully bridged the gap between these and those books intended for the academic high-brow.

The present edition has been thoroughly revised and, in order to bring it completely up to date, a large amount of new matter has been added dealing with negative feed-back, automatic tuning and automatic selectivity control. The simple directness of the technical explanations, which were so greatly appreciated by readers of the earlier edition, has been preserved in dealing with the new matter. N.P.V-.M.

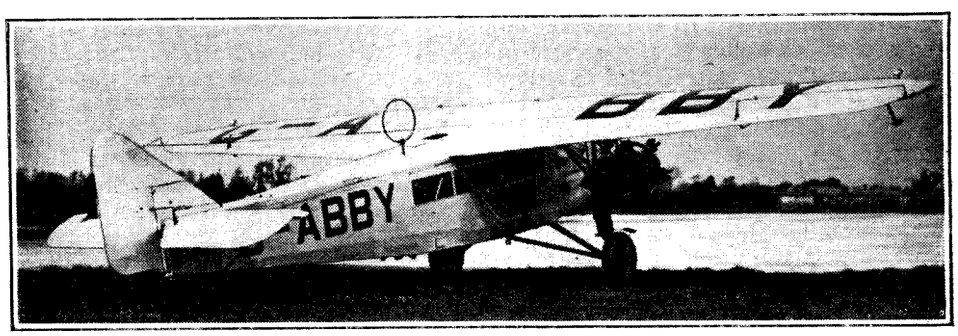
Training Aircraft Operators

DEVELOPMENTS AT HAMBLE

By J. A. McGILLIVRAY

HAMBLE Radio, call-sign G V B, is now operating regularly and using the wavelength of 193.5 metres (1550 kc/s), and is consistently heard within a radius of 150-200 miles from Southampton.

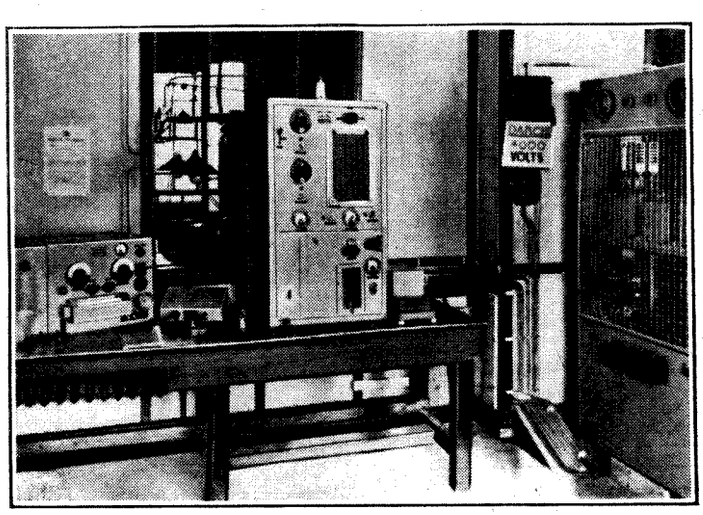
Four of the aircraft belonging to the school fleet of Air Service Training, Ltd., Hamble, are now fitted with wireless, and three types of Marconi apparatus are in use, in order to give the students a wide experience. The craft fitted with wireless are all multi-engined, and the apparatus used are Type AD6M, AD37/38 and AD77/6872. All the machines are fitted with D/F and homing receivers, identical with those fitted on the largest Imperial Airways air liners. Towards the end of the wireless course those students who have passed a proficiency bar examination are allowed to act as an operator on an aeroplane, under the supervision of an instructor. After obtaining the P.M.G. Aircraft Certificate they are allowed to act as operator without supervision, between turns of other duties as pilot and navigator.



Avro V air liner used for wireless instruction at Hamble. Note DF loop and fixed aerial from wing tip to tail fin.

The machines fitted with wireless are used chiefly for advanced instruction. Long flights are made over land and sea to give comprehensive experience to the personnel aboard, and full use is made of wireless and DF during these trips.

The main ground station at Hamble is also Marconi equipped. The transmitter is Type TW5, radiating 250 watts. It is supplied entirely from the local 3-phase mains through rectifiers which deliver 200 milliamps. at 3,000 volts to the anode of the magnifier valve. CW or MCW telegraphy or telephony can be radiated, the carrier being 80 per cent. modulated on telephony.



The ground station at Hamble. Left to right are seen the DF612 receiver, TW5 transmitter, relay unit and HT rectifier panel.

A recent addition to the ground equipment is an Adcock short-wave direction-finder with a wave-range of from 15 to 220 metres. This has been built 600 yards from the transmitting station in order to reduce local interference. The transmitter can be controlled from the DF station through a landline by a system of relays.

The Adcock station was erected entirely by the instructors and pupils of the wireless section of the school. The mast-aerials are of galvanised steel tube, each 30 feet high and entirely self-supporting. The bases are mounted on insulators and anchored securely to concrete foundations. Screened feeder cables are used to connect the mast-aerials with the direction-finder.

Low-capacity Cable

The feeder cables are lead covered, one inch in outside diameter, with a core of 7/.012 copper wires. The core is kept in the centre by means of mica beads every three inches; the dielectric thus consists mainly of air. The feeders are very carefully matched and are buried six feet underground.

The DF receiver is a very selective, high gain, nine-valve super-het., operated entirely from batteries. Auto-gain control is fitted for all-round reception, and manual control of RF and AF gain is also fitted.

Calibration of the station for direction-finding has to be effected on each wavelength in use, and that is a lengthy process. Bearings have to be taken every few degrees all round the compass, and error curves drawn up so that the bearings as sent to the aircraft will be accurate.

Automatically Regulated Deaf Aid

By W. W. KENYON

An electrical hearing aid, in its simplest form, suffers from various disadvantages and limitations, which are discussed in this article. Means for overcoming the usual shortcomings are described, and the author's suggestions are exemplified by a design for an amplifier with automatic regulation.

AVC Principles Applied to a Microphone Amplifier

It is highly desirable that the volume of sound output from any hearing-aid equipment shall be automatically independent of sound input to the microphone over a wide range of variations of this input. In addition, a system of manual control must be fitted to each telephone so that the controlled output can be further adjusted to suit the individual listener's ear. In the absence of any system of automatically controlled output, if a deaf person wanted to follow every word of the speaker, he would be continually adjusting the manual volume control. Even so, it would be almost impossible to avoid an occasional burst of excess volume which would consequently cause aural discomfort to the listener. In addition, automatic control of output with varying input energy can be so arranged that serious overloading of the amplifier link is virtually eliminated. This is a decided advantage, since in the majority of cases the hearing-aid equipment is required to function unattended for long periods. The hearing-aid which is described has been designed with these points in view.

The amplifier link consists of two stages, the first stage containing a "variable-mu" screen grid valve and the second stage an output triode. Resistance-capacity intervalve coupling is employed between the amplifier stages, as shown in the circuit diagram. A voltage step-up coupling was found unnecessary owing to the amplification afforded by the first stage. The fixed grid bias for both stages is derived from resistances in the respective cathode circuits. These resistances are shunted in the usual manner by electrolytic condensers.

Transformer coupling is employed between the amplifier output stage and the telephones, the primary of this transformer being directly connected in the anode circuit. The secondary is provided with tappings to suit the number of telephones in use at any one time. The core and one side of the secondary winding are earthed for safety.

Automatic control of the output from the triode valve is effected as follows. A portion of the output signal, after rectification, is fed back to the control grid of the first stage, thus varying the amplification of this stage and maintaining a fairly uniform output level.

The output signal is fed into a condenser-resistance network connected between anode and earth of the triode valve. A metal rectifier, in series with a resistance R1, is connected between the earth side and a variable tapping on the resistance network. The DC potential developed across this resistance R1, after smoothing by a filter circuit, is fed back to the control grid of the variable-mu valve. The amount of control depends upon the strength of the output signal and the position of the tapping on the resistance network. The position of this tapping, once adjusted for a given set of conditions, requires no further adjustment.

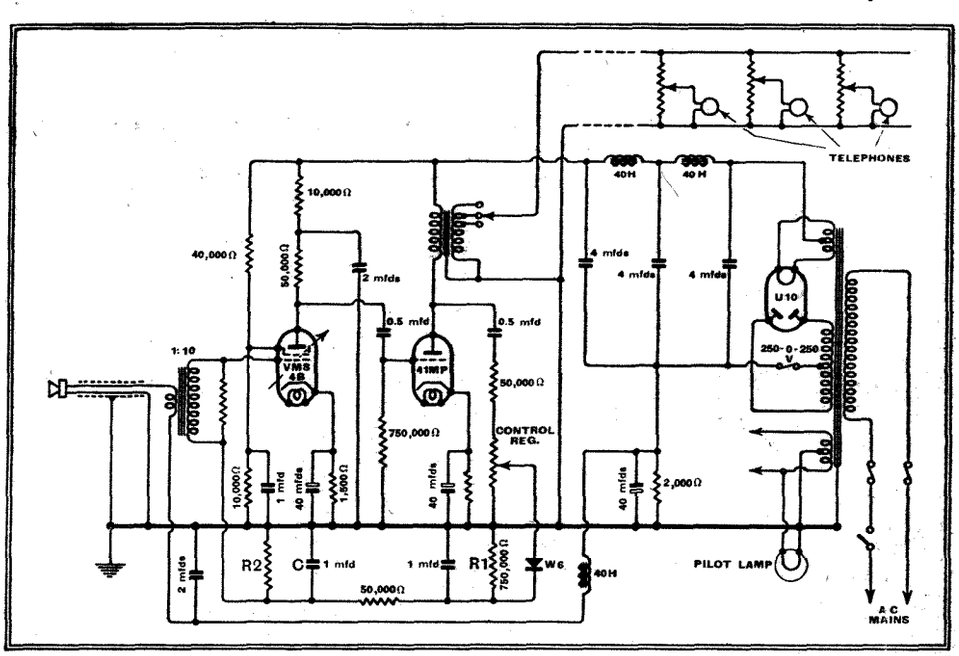
One apparent disadvantage of this arrangement is the tendency to produce an unintelligible noise in the telephones. In actual practice, however, this is not the case, as the filter circuit will only allow the passage of very low frequencies and direct current. It also has a time lag. With suitable adjustment of the time lag, however, by means of resistance R2 across condenser C, individual words are quite clear and undistorted both immediately before and after a loud signal. With loud and sustained noises, such as hand-clapping, the feed-back voltage to the first stage remains constant and a reduced output signal is obtained. The HT for the amplifier stages is supplied by a full-wave valve rectifier.

Smoothing is effected by means of double chokes and condensers, thereby reducing any mains hum which may be introduced into the amplifier through the HT line. The LT for both stages is supplied by a 4-V winding on the mains transformer. This transformer and the smoothing chokes are of the metal-shrouded type, the shrouds being earth connected.

The microphone used, a Siemens' Neophone, is of the carbon granule type, possessing a good speech characteristic and high sensitivity. The latter characteristic is important in order to render audible those sounds which the deaf person cannot normally hear.

The polarising voltage for the microphone is obtained automatically from the drop across a resistance in the common-negative HT line, this supply being further smoothed with a choke-condenser filter circuit before it is applied to the microphone.

The amplifier components are mounted on a metal chassis, the mains components and valves being placed on the upper side. The mains transformer is positioned on a wooden block so as to reduce any mains



Circuit diagram of a microphone amplifier with automatic gain control.

Automatically Regulated Deaf Aid—

hum which may be caused by magnetic induction between it and the microphone transformer. All other components are mounted on the underside of the chassis, the screening being completed by means of a metal plate, covering the underside of the chassis. Complete screening of the upper side of the chassis is effected by means of a metal box. This is provided with an internal panel to separate the valves and mains components. The screening box has a perforated metal window to provide ventilation for the valves.

The microphone lead socket is mounted on one end of the chassis, the fuses, main switch, and mains signal lamp the other end. The telephone line socket, output transformer tappings and main earthing terminal are mounted along the side of the chassis.

A hearing-aid equipment of the type described has been in use in a church for the last two years. No attention has been necessary throughout this period. The equipment is used to supply energy to 20 listening points, each listening point being provided with a manual volume control and 2,000-ohm single earpiece, the telephone leads to the latter being connected internally. All telephone leads to the listening points, and microphone lead, are carried in lead-covered cable, the outer sheath of which is earthed.

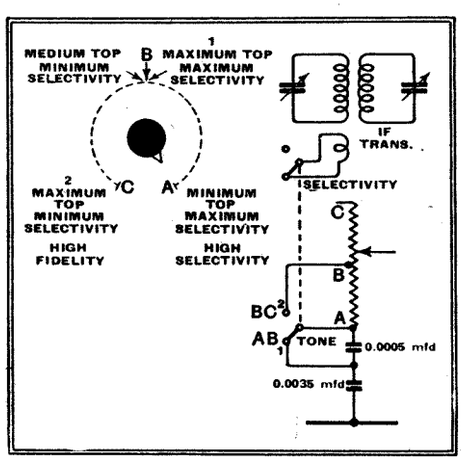
Simultaneous Selectivity and Tone Control

COMBINED selectivity and tone controls are by no means unknown, and there are many possible arrangements. One system is to use a continuous tone control and a two-position selectivity switch in such a manner as to obtain a continuous variation of overall modulation frequency response.

This may be arranged by using a variable resistance or potentiometer having at an intermediate position in its travel a switch ganged to the two-position selectivity switch. The potentiometer forms part of the tone-control circuit, and its switch is arranged to short-circuit part of that circuit so that the operation is as follows:—

Starting from one end of the control the selectivity switch is in the maximum position (that is, minimum band-width), while the tone control is giving minimum AF response. On moving the control around to the switch position the AF response is improved without decreasing the RF selectivity. On operating the switch the selectivity is reduced (band-width increased) and the tone-control circuit is simultaneously modified to give increased top cut so that the overall response after operation of the switch is approximately the same as it was just before the operation of the switch. On continuing the movement of the control the AF response is continuously improved, while the selectivity remains in the broad-band position until the position of no top cut is reached.

A method of carrying this out is illustrated in the diagram, in which the points ABC on the potentiometer resistance are shown in relation to the movement of the manual control. At the point B, moving from A towards C, the selectivity switch is operated to give increased band-width and the potentiometer switch is simultaneously operated so as to move from contact 1 to contact 2. It will be seen that this has the effect of putting in circuit the 0.0005 μF condenser, which limits the severe action of the 0.0035 μF condenser, and simultaneously short-circuits the portion AB of the resistance so as to increase



A tone control operating in conjunction with variable selectivity is shown here.

temporarily the amount of top cut.

The two-position selectivity control may be of any convenient type; for example, that in which the coupling between two IF coils is modified by switching in and out a small intermediate coil.

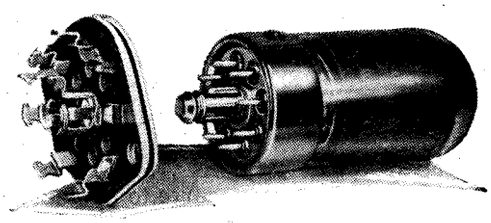
New American Television Valve

SYLVANIA 1231 PENTODE

DETAILS of a new American valve of especial interest are now to hand; this is the type 1231. The special feature of the valve is that although it is a screened pentode it has no top-cap, but all connections are brought out to the 8-pin base. This base is not the conventional moulding, but is a part of the glass envelope of the valve. Actually, the pins are formed of the leading-out wires through the glass. A metal shell fits over the base and bears a metal centre-spigot similar to that of the ordinary octal-base. It also carries a locking device, however, which holds the valve firmly in the socket.

This metal shell and centre-spigot are earthed, and the grid and anode pins are diagonally opposite. Consequently, the spigot acts as a screen between them, thus permitting all leads being taken to the base without destroying the internal screening of the valve.

The particular construction and the absence of a conventional base lead to an extremely small valve with short internal



The new Sylvania valve and its holder.

leads and low losses. The length apart from the pins and spigot is only 2-13/32in. and overall $2\frac{7}{8}$in., while the diameter is $1\frac{3}{16}$in.

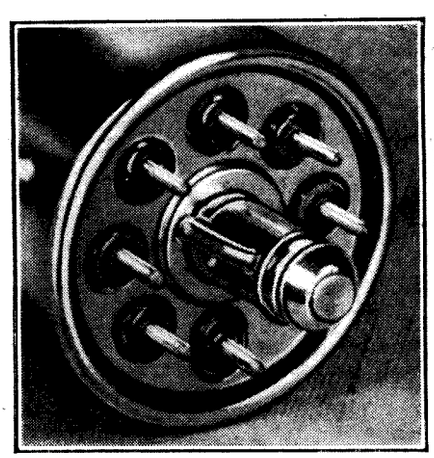
It is an indirectly-heated valve taking 0.45 ampere at 6.3 volts, and the inter-electrode capacities are: grid to anode, 0.015 $\mu\mu$F.; grid to earth, 8.5 $\mu\mu$F.; anode to earth, 6.5 $\mu\mu$F.

When used as a pentode the suppressor is tied to cathode and the valve is operated with 300 volts for the anode and 150 volts for the screen. A cathode-bias resistance of 200 ohms should be used, and the anode and screen currents are 10 mA. and 2.5 mA. respectively. A mutual conductance of 5.5 mA/V. is obtained with an AC resistance of 0.7 MΩ.

By tying the suppressor to screen the valve can be used as a tetrode. The screen and anode potentials and bias resistance are the same, but the anode current rises to 12.0 mA. and the screen current falls to 0.5 mA. The mutual conductance becomes 6.5 mA/V. and the AC resistance 0.54 MΩ.

The valve can also be used as a triode. Both screen and suppressor are then joined to anode. The maximum anode potential should be 250 volts and the bias resistance 400 ohms. The anode current is 13 mA., the mutual conductance 6.3 mA/V., and the AC resistance 5,200 ohms.

The valve does not fit a standard octal socket, although the pin arrangement is similar. Adopting the pin-numbering of the standard octal-base, the connections



Enlarged view of the base of the valve.

are: 1, heater; 2, anode; 3, screen-grid; 4, suppressor grid; 5, shield; 6, grid; 7, cathode; 8, heater. The valve is obtainable in this country from Messrs. Claude Lyons, Ltd., of 40, Buckingham Gate, London, S.W.1, and is priced at 30s.

UNBIASED

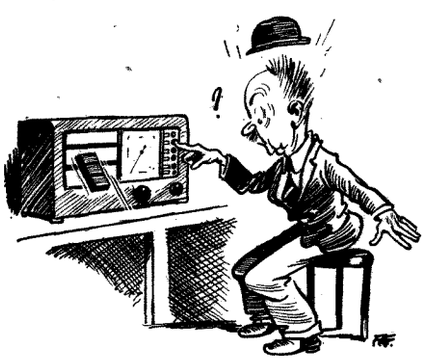
By FREE GRID

Automatic Tuning : Its Real Significance

IT is astonishing what a lot of nonsense you see written nowadays concerning new wireless developments, and I often wonder if these writers pause to think before they commit such balderdash to paper. The particular piece of drivel which has got my back up is the description in a certain Colonial journal of automatically tuned receivers, which will undoubtedly loom large in this year's Radio Show.

The writer, after getting off his chest a few ponderous platitudes about radio being still in its infancy, goes on to describe the working of push-button receivers and states that people will only have to press a button bearing the name of the station they want to receive and "they will be amazed to hear its programmes coming from the loud speaker." Personally, I should have thought that, so far from being a cause of amazement, this would be exactly what would be expected to happen. It would, I think, cause the average listener far more astonishment if, on pressing the button, a bar of chocolate came out of the loud speaker.

Another point which annoys me is that nobody seems to realise the true significance of automatic tuning of the motor-driven type. Even *The Wireless World*, I am sorry to say, seems to visualise nothing better than the eventual development of remote control units which will enable people to sit in their armchairs and tune in the station they want. The real value of this development is, of course, that it will eventually solve the interference problem by enabling us to put our sets at the end of our back gardens away from the interference reradiated by the house-wiring. At present we have available some very praiseworthy anti-static aerials, but, in the case of many receivers, the aerials' efforts are set at naught owing to the fact that interference is picked up direct on the internal wiring of the set, which is, in many cases, very inadequately screened.



Far more astonishing reception.

As it is hopeless to expect set makers to do anything about this, we shall have to erect our anti-static aerials as hitherto but put the sets at the bottom of the garden out of harm's way and tune them by means of a remote control unit. I think I am right in saying that this is only possible with the motor-operated type of autotuning, but I am willing to be corrected.

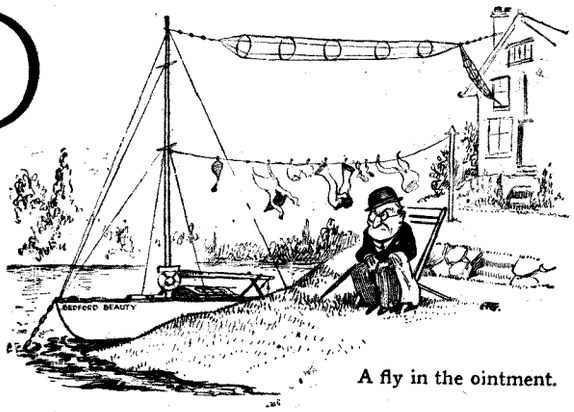
More Trouble

WHEN I was very young I recollect reading with great interest about the nomadic habits of the Bedouins, who apparently have no settled abiding place but spend their lives wandering from pillar to post. I little thought then that the day would dawn when I should, by force of circumstances, be compelled to emulate their example. Such is the case, however, and I find myself in yet another new dwelling place after only a few months' sojourn in the other, owing to the fact that Mrs. Free Grid got fed up with the neighbourhood, or the neighbourhood got fed up with her—I am not sure which.

Having arrived at my new domicile, which incidentally is one of those riverside dwellings where, in the summer, the river is at the bottom of the garden, and in the winter the garden is at the bottom of the river, I at once determined to erect an aerial mast that was really worthy of me, and decided upon one of about 60ft. in height.

Consequently, I at once wrote round to all the suppliers of these articles and was literally staggered at the prices I was asked. As everybody knows, a 20 or 30ft. builder's pole can be had for a pound or two, but above this height the price apparently goes up out of all proportion to the extra footage. The lowest quotation I received for a 60ft. mast was a pound a foot, and the dearest offered to me cost £80.

Needless to say, I had no intention of being held to ransom in this fashion but, at the same time, I was equally determined to have my 60ft. mast, and after a good deal of profound meditation I at last solved the problem. As many of you may know, when a racing yacht eventually becomes unseaworthy and goes to the shipbreaker's yard there are several parts of her which are still quite sound, and one of these is the mast. Unseaworthy as she may have become, a superannuated Cowes relic is at least capable of floating and I, therefore, proceeded to nose round the well-known shipbreakers' yards and eventually secured what I wanted. The result is that she is now safely moored at the end of my garden and her mast makes a fine support for the far end of my antenna.



A fly in the ointment.

Unfortunately, there is a fly in the ointment, as there usually is. Mrs. Free Grid insists on using the mast to support the far end of her clothes line as well as the aerial. Despite my protests she continues to do it and, to say the least, it looks extremely undignified to see several pairs of —pardon me, ladies—men's underpants waving in the breeze underneath the aerial.

I have been thinking very hard to try and find a method whereby I can deter her from this practice and am wondering whether if I went in for transmitting again I could induce a sufficiently powerful signal from the aerial to the wet clothes line to cause sparks to fly off it on to her hands when she reaches up to peg out the washing. Possibly some of you transmitting fellows could advise me in this matter and I am, therefore, waiting very anxiously to hear from you.

Thank You

I MUST take this opportunity of thanking the large number of readers who responded to my recent appeal for help in the matter of preventing the din from a petrol outboard motor from drowning out the efforts of my portable wireless set when I am out on the river in my canoe. It appears that I was quite wrong in assuming that there was no such thing as a totally submerged motor. Apparently one does exist, but its *raison d'être* is not so much that of silence as of obtaining an efficient cooling system free from all the complications of circulating pumps. Nevertheless, it ought to suit my purpose admirably, as it makes just sufficient noise to avoid the suspicion which would, I fear, attach to me were I to indulge in one of the super-silent all-electric ones I mentioned.

Indoor or Frame Aerial?

By F. R. W. STRAFFORD
(Research Dept., Belling and Lee, Ltd.)

MEASUREMENTS ON THE TWO TYPES

DESCRIBING an investigation into the relative merits of indoor aerials of varying lengths and a frame aerial of a size practicable for domestic use. Measurements were made on the effectiveness of signal pick-up and susceptibility to interference (signal/noise ratio) of each type.

THE relative performance of indoor and frame aerials does not appear to have received much attention hitherto, although there are many cases where, as an outdoor aerial cannot be erected, one or other of these alternatives must be chosen. It is the purpose of the writer to discuss in some detail the factors by which the relative performance of indoor and frame aerials may be accurately assessed and to provide practical measurements for these determinations.

The primary function of any receiving aerial is that of developing the maximum attainable effective voltage from the electromagnetic field of the desired signal. Accordingly, the first part of the investigation will concern itself with the measurement of the relative effectiveness of signal pick-up between indoor and frame aerials respectively.

These measurements were conducted in a wooden building measuring 25ft. by 15ft. inside (one room). The indoor aerial comprised a vertical portion leading down from a point at a height above floor level equal to that of the average picture rail. The length of the vertical portion, which terminated at the measuring apparatus upon the bench, was about 5ft.

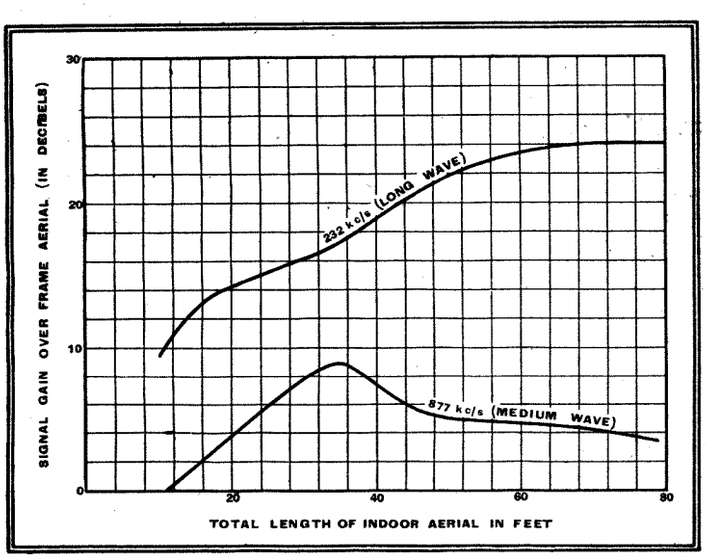


Fig. 1.—The indoor aerial proved to be the better collector of signal energy. These curves show gain in pick-up of a picture rail wire as compared with a frame

The horizontal portion was mounted upon well-spaced, stand-off insulators of the midget type located along the picture rail, and various total horizontal lengths up to 75ft. could be employed. Naturally, when more than 25ft. of horizontal portion was in use, the direction of the remainder changed in accordance with the direction of the walls of the building.

Separate frame aerials were employed for medium- and long-wave bands. These frames were of the square type, each side being 18 inches in length. Twelve spaced turns of No. 26 DCC were used for the medium-wave band of 200-550 metres while 48 close wound turns were used for the 1,000-2,000-metre long-wave band. During the measurements the frame was always oriented, in the horizontal plane, for maximum response to the desired signal.

The measuring apparatus consisted of a highly screened and accurately calibrated receiver especially suited to this class of investigation. The input impedance was rendered very high and substantially aperiodic in order that no deleterious effects were produced as a result of the measuring instrument actually disturbing the true magnitude of the voltages developed across the two aerial systems.

Fig. 1 shows the gain in signal pick-up of an indoor aerial as compared with a frame, and strikingly illustrates the superiority of even a moderate length of indoor aerial. These curves have been taken on London Regional (877 kc/s) and Luxemburg (232 kc/s).

Listeners in the north who naturally obtain weaker field strengths from long-wave European stations than do those in the south will particularly appreciate the advantage of using an indoor aerial rather than a frame—always assuming an outdoor aerial is out of the question.

The curve for 877 kc/s is interesting in that it exhibits a maximum when the length of the indoor aerial is of the order of 34 feet. The decrease in pick-up for greater lengths of wire is presumably due to voltage cancellation effects arising from the gradual folding of the horizontal portion as it progresses round the walls. This effect theoretically occurs more readily as the signal frequency decreases—hence the absence of the effect on 232 kc/s.

Now that the respective "collecting efficiency" of indoor and frame aerials has been compared it is necessary to investigate their relative behaviour to a superimposed field of electrical interference of the "crackle and mush" variety.

Such a field is invariably produced by the electrical interference currents generated by some commutating or contacting device, and these currents are propagated along the house wiring of a building, thereby creating an aurora of electric and magnetic force disseminated in a complex manner throughout and around the whole building. These fields will induce currents in neighbouring conductors such as the frame and indoor aerials under consideration.

In order to simulate practical conditions for the purpose of obtaining comparative measurements, an electric motor was connected to one of the lamp sockets in the laboratory. This motor was of the commutating type and was known to produce a high level of interference due to its worn commutator and brushes. The preliminary field strength measurements indicated a fairly uniform field of interference distributed throughout the room with an occasional minimum at certain points near the centre.

Twice as Good

The frame aerial was located at a point of average interference level although it must be remembered from a practical viewpoint one would choose the point of minimum disturbance whereas such a procedure is almost impossible with an indoor aerial on account of its distributed length.

As a result of the experiments it was definitely established that under the conditions of measurement an average improvement of 7 db. (just over two to one) was exhibited by the frame as compared with the indoor aerial. The curves of Fig 2 illustrate the results.

In summarising one therefore concludes that:—

(1) Where no serious interference exists an average indoor aerial is generally superior to an average frame aerial as regards signal pick-up.

(2) Where electrical interference is prevalent a higher signal-to-noise ratio will probably be obtained with the frame aerial at the expense of signal strength, particularly on the long-wave range.

The choice of either system thus appears to be largely determined by the extent to

Indoor or Frame Aerial ?—

which localised interference is prevalent.

In practice the figure of 7 db cited for the improvement in signal/noise ratio with the frame aerial is likely to be exceeded by placing the frame in the minimum interference field. In certain cases the signal will be arriving from a direction such that when the frame is oriented at maximum in respect of the signal, it is fortuitously at minimum with respect to the interference.

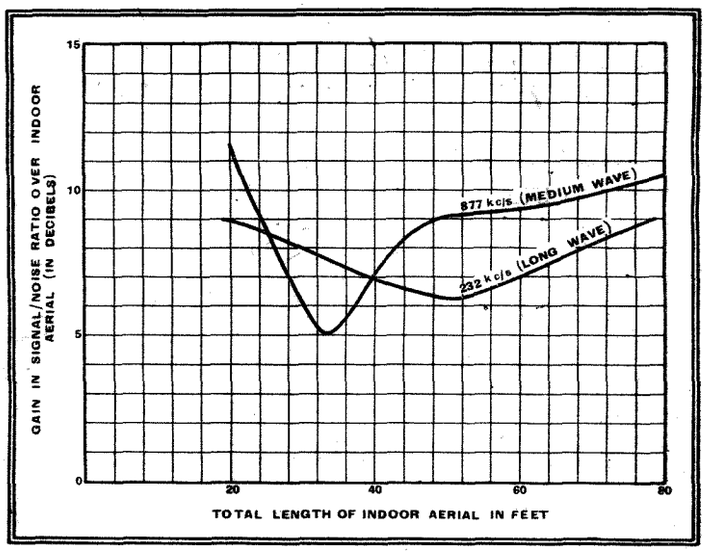


Fig. 2.—On the score of immunity from interference, the frame was found to have the advantage; its gain over an indoor aerial in signal/noise ratio is indicated by these curves

Five-Metre Reception

Some observations and conclusions drawn from a day's listening on the ultra-high frequency band.

By H. B. DENT (G2MC)

IN due course the reports of those who took an active part in the five-metre national field-day held by the Radio Society of Great Britain on Sunday, July 3rd, will no doubt be known, and comparison of the results obtained in different localities should prove very interesting.

In the meantime we can sit back and think over our individual experiences, and see what we have learned on this occasion. Those particularly interested in the reception side of the business, if reasonably well situated, should have logged at least a dozen stations, though this can only be said with any certainty in regard to listeners in the south of England. Listening at home and about 16 miles N.W. of London, the writer was able to identify eighteen different stations, though several weak carrier waves were also heard but not identified.

In a district which is solely residential the amount of electrical interference was very severe, though the bulk of it admittedly came from motor cars and aeroplanes, of which North-West London seemed to have more than its fair share on this day.

The receiver used was an eight-valve superhet for which, it is thought, can be claimed quite high sensitivity. But for the aforesaid interference, it is certain that the day's bag could have been considerably improved, for several call signs were drowned by local noise.

This kind of interference is a definite obstacle in the way of good five-metre reception, and, unfortunately, there is not very much the listener can do to combat it. Possibly the best that can be done is to fit a form of interference limiter, of which there are some reasonably simple circuits known. By this means it should be possible to reduce the noise of car and aeroplane engines to a tolerable level.

The aerial plays an important part in five-metre reception, and although the vertical di-pole, in one form or another, still has some adherents, the majority of transmitters now appear to be using horizontal arrangements, so that a similar system ought to be employed for reception. Being bi-directional is possibly a disadvantage of the horizontal aerial, but as it does seem to put out a better signal its adoption will doubtless soon become more general.

Rotatable Aerials

It is thus very important that the receiving aerial, if horizontal, be capable of rotation through at least 90 degrees. Alternatively, two aerials at right angles to each other can be used, the simplest arrangement being separate aerials well spaced, and with their feeders brought to a change-over switch marked north-south and east-west respectively in the two positions.

For some time this arrangement obtained at the writer's station, but was subsequently replaced by one rotatable horizontal half-wave di-pole which has so far proved to be the better of the two schemes.

It had been hoped to try out on this occasion a rotatable affair consisting of two half-wave elements spaced one-eighth wavelength apart, which has been described as a "flap-top beam," but plans miscarried and the gear could not be got ready in time. Possibly the opportunity may be afforded to deal with this idea some time in the near future, after it has been tried out and compared with the existing di-pole.

The general conclusions that emerge from this day's test can be briefly summed up as follows: Reasonably good distances, say, up to 50 miles, can be covered by quite a low-power transmitter if it radiates a perfectly steady carrier, crystal control being easily the best way of achieving this end. It is gratifying to record that almost all the stations, including the portables, heard on this occasion were using either crystal control or some form of frequency stabilisation.

With stabilised transmitters it becomes possible to use quite sensitive superheterodyne receivers, while a good straight set having Acorn RF and detector valves would put up an excellent performance under these conditions.

A good transmitter site is most desirable, for in the past one particular portable station, though of quite low power, had put in at the writer's station an excellent signal when occupying a certain position south of London. On the field-day Sunday, however, its signals were not heard, so it was obviously less favourably situated for northward transmission. On the other hand, another portable station which took up the exact position previously occupied by the first-mentioned portable was putting in a very strong signal indeed, yet only about 7 watts were used and the distance was approximately 40 miles.

There is a lot still to be learned regarding the best aerial system for low-power five-metre transmission and reception. Fortunately, on this wavelength, reasonably compact directional arrays can be built and erected so that they are rotatable, and the experimenter will find this an interesting subject for study.

One need not now wait for an organised field-day for five-metre transmissions, as on most evenings there are usually a half-dozen quite strong signals to be heard in the vicinity of London, and no doubt elsewhere in the country as well.

The following five-metre stations were logged by the writer on Sunday, July 3rd, between 11 a.m. and 7 p.m. B.S.T. The letter (P) after the call sign indicates the station was on portable location and not working from the fixed situation: G2HG, G2JK(P),* G2JQ(P), G2KI, G2MV, G2NH(P),* G2OD, G5AU,* G5KH, G5RD, G5RD(P), G6GR, G6VA, G6XM, G6YP, G8IX,* G8OQ(P), G8NV.

* Contact was established with these stations using either ICW or telephony.

The "Flight" Handbook. By W. O. Manning, F.R.Ae.S., and the Technical Staff of "Flight." Pp. 142 with 106 illustrations and diagrams. Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 3s. 6d. net.

NOW that so much attention is focused on the subject of flying many people are anxious to obtain some knowledge of the principles which govern it. For the most part the available books are intended only for the aeronautical engineer, the ordinary man having to rely for his knowledge on various articles which appear from time to time in the popular Press. This book, while calling for no special knowledge on the part of the reader, makes a serious and very successful attempt to collate all the information necessary to enable the ordinary man to obtain a grasp of the theory of aeronautics. The book shows how such theory is applied to the various designs and methods of construction used in aircraft manufacture.

A section of the book is devoted to a description of the instruments upon which a pilot relies for controlling and navigating his machine. There is, in addition, a good deal of information on the subject of gliders and sailplanes. Balloons and airships are similarly dealt with. N.P.V.-M.

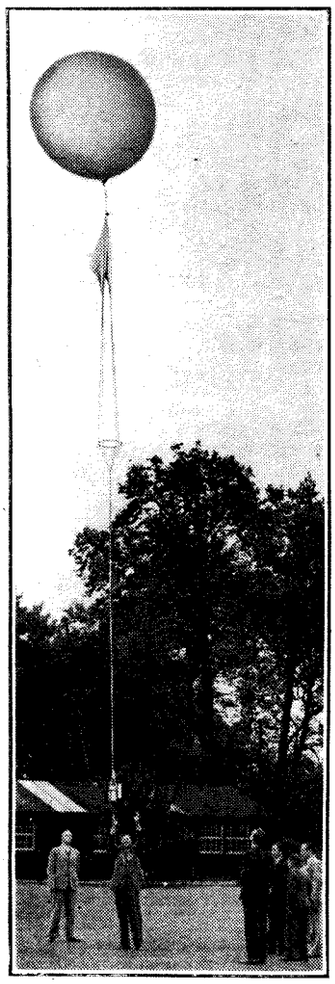
NEWS OF THE WEEK

FIVE-METRE DX

Two-way Working with Italy

WHAT is believed to be a record for British long-distance working on five metres has been set up by Mr. E. Menzies, G5MQ, of Woolton, Liverpool, who maintained two-way contact on 56 Mc/s with Italian 1IRA from 15.00 to 15.45 B.S.T. on Saturday, July 2nd.

Telephony was used by both transmitters, the Italian employing 100 watts and the G5MQ 25 watts. 1IRA was received on the loud speaker at R8 fading to R2, whilst 5MQ was received at R5. Mr. Menzies was using a National one-ten receiver and a half-wave vertical dipole 30 feet above the ground which is roughly 250 feet above sea level.



WIRELESS EQUIPPED meteorological balloons are being used by the National Physical Laboratory for obtaining information regarding upper atmospheric conditions. The ultra-short-wave apparatus transmits continuously from the time the balloon starts to ascend to the time it bursts, when the parachute, seen below the envelope, brings the apparatus safely to earth.

FRENCH NEWS CUTS

Result of Press Agitation

NEWS bulletins from the French State and private stations have, from the beginning of this month, been reduced from one-and-a-half hours to twenty-one minutes as a result of the pressure brought to bear upon the Government by newspaper proprietors during the past year, who assert that the broadcast news has an adverse effect upon newspaper sales. So far as the private stations are concerned this result has little effect for a very large percentage of them are owned by newspapers.

The Press review, during which extracts from the leading articles of English and French newspapers have customarily been broadcast, has been abolished.

The Position in England

When such drastic measures as these are taken in other countries, English listeners should surely be all the more grateful for the news service rendered by the B.B.C., which occupies approximately 1¾ hours.

Whilst many listeners and radio critics are pressing for an extension of the B.B.C.'s news service, it is well to remember that the Corporation is very much in the hands of the Press, for in the B.B.C.'s 1928 Handbook it is stated that "Before the (British) Broadcasting Company was actually formed, the newspapers induced the P.M.G. to agree that the new organisation could distribute news only at their sufferance. Thus, when the B.B.C. began to transmit, it found itself considerably handicapped in the news side of its work." The only change under the new agreement between the B.B.C. and the Newspaper Proprietors' Association is that the Corporation is not to be confined to the four agencies for its news.

BLIND LANDING

New System may be Installed Throughout the U.S.A.

IN the specification drawn up by the Bureau of Air Commerce, U.S. Department of Commerce, for the manufacture and installation of its new aeroplane instrument landing system, the outstanding features of the principal systems at present in use are to be incorporated. It is expected that the results of this development will become the official system which will provide airports and aeroplanes in the States with a uniform method of blind landing.

ISLE OF WIGHT MARCONI MEMORIAL

Earliest Experiments Recalled

IT is proposed to erect a memorial tablet to Marconi at Alum Bay, Totland, Isle of Wight, for it was here that he carried out some of his earliest experiments in this country. During a recent meeting at Freshwater, Mr. J. B. Garlick, ex-postmaster at Totland Bay, recalled that when young Guglielmo Marconi entered the Post Office at Totland Bay seeking the assistance of a morse operator he (Mr. Garlick) volunteered his services, little realising that he was helping in the initial stages of what was to become the greatest influence in the twentieth century.

It was also disclosed at this meeting that the original 160ft. mast used by Marconi for his experiments in the Island was, a few years ago, secured for the Marconiphone Company, and subsequently used for the first television experiments at Alexandra Palace where, it is understood, although shortened, it is still in use.

THE DESIGNER of the apparatus for the meteorological balloon, Dr. Thomas, who is a member of the staff of the Radio Department of the N.P.L., is here seen holding the apparatus which works on 8.5 metres and was described in our last issue. A request, in English and French, that the finder sends the apparatus to the N.P.L. is attached to the equipment.

A.P. LINE TESTS AFTER HOURS

A *Wireless World* reader happened upon an interesting test by the Alexandra Palace sound transmitter after 11 p.m. on July 1st. A light orchestra in the studio played alternately under "Test A" and "Test B," and enquiry revealed that in one case the modulated microphone currents were being conveyed to the transmitter via line to Broadcasting House and back. In the other the normal link to the control room was used. The tests were carried out to determine what loss, if any, was noticeable on a long line, and it is understood that the results were of an encouraging nature.

B.B.C. TRADE BULLETINS

MUCH premature publicity in the daily Press has been given to the B.B.C. proposal—which had barely left the embryotic stage—to broadcast bulletins of commercial news in which the Corporation's principle of not mentioning names of firms would be abandoned.

In the official announcement the B.B.C. stated that it had been considering including, in the interests of British industry as a whole, a short weekly bulletin of industrial news. The statement made it clear that the matter had not yet got beyond the stage of preliminary enquiry.

INTERNATIONAL TELEVISION

ON the Downs near Brighton, experimenters were recently successful in receiving, at good programme value, the television transmissions from the Eiffel Tower. Whilst this does not constitute a record distance for the reception of television, for a Middlesbrough experimenter, at 220 miles, received the Alexandra Palace transmissions a few weeks ago, it does mark a milestone in the history of international television. It must be remembered that the Downs, at the point where the receiver was situated, being approximately 600ft. above sea-

News of the Week—

level, was an exceptionally good position for the reception of Paris.

N.B.C. YEAR BOOK

Report of Company's Eleventh Year

"AS a detailed report in word and picture of N.B.C.'s march along the airways to greater service in the National benefit during 1937, the Year Book is presented." So reads the close of the foreword to the 1937 Year Book of the National Broadcasting Company of America, which deals pictorially with the eleventh year of the company's existence.

It is reported that forty-one broadcasting stations were added in the United States and Canada to the N.B.C. network during 1937, bringing the total to 143.

England heads the list of countries supplying programmes relayed by the N.B.C. with nearly 200, whilst the next on the list is France with 40 programmes.

A very limited number of copies of this Year Book, which contains thirty-two pages, is available from the National Broadcasting Company Inc., Electra House, Victoria Embankment, London, W.C.2.

LISTENERS' LIKES AND DISLIKES

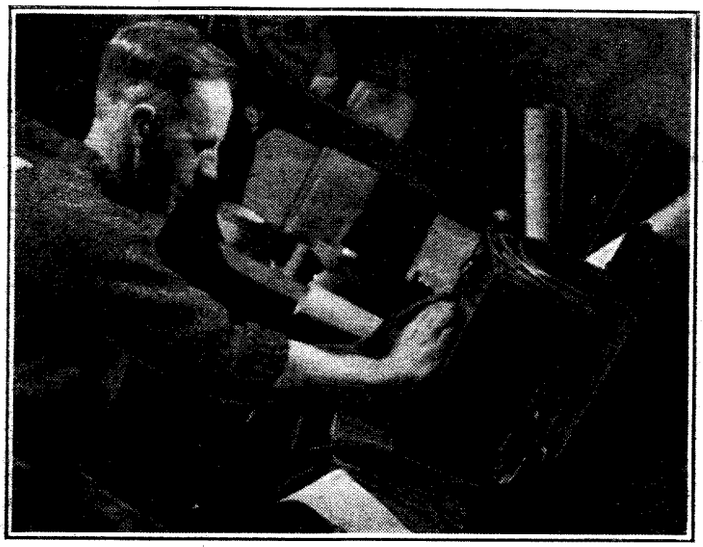
Further Stage in B.B.C. Research

CONTINUING its researches into the likes and dislikes of listeners, the B.B.C. invites them in its latest questionnaire to name the kind of programmes they like and answer some questions about summer listening habits. Listeners willing to help are asked to send a postcard marked "Questions" to Broadcasting House, London, W.1, giving their name and address and the number of forms required.

To ensure that every type of listener is, as far as is possible, represented, the questionnaire will also be sent to 5,000 licence holders whose names will be picked out, according to a statistician's formula, by the G.P.O.

PROGRAMMES BY WAVELENGTH

THAT different wavelengths should be used for different types of broadcasts has been suggested in *The Wireless World* more than once, and the idea reappeared in a national newspaper last week. The B.B.C. recognises that in theory the idea is good, but fears that in practice the result would be that large numbers of listeners would be denied access to their favourite programmes, for correspondence at Broadcasting House reveals that many people are unable to get much more than the local station.



THE SKIPPER of the Aberdeen trawler, *John Gillman*, at his radio-telephone transmitter. This is a "still" from the documentary film, "North Sea," made by the G.P.O. Film Unit, which faithfully portrays the adventures of the trawler during the severe weather of February last year. This film, which is now showing at the Carlton Theatre, Haymarket, London, S.W.1, tells of the unremitting efforts of the staff at the Wick radio station to bring help to the crippled vessel.

U.S. ARMY'S MOBILE PUBLIC ADDRESS SYSTEM

A NEW high-powered mobile public address system made by the R.C.A. Manufacturing Company has recently been added to the equipment of the Signal Corps of the U.S. Army. The new unit, one of the largest of its kind in the United States, was used officially for the first time by the President on July 3rd.

It is the most powerful and completely equipped unit in the Army, and under normal operating conditions is capable of projecting sound to an audience of at least 100,000. It is equipped with an efficient receiver and recording turntables.

"SCRAPBOOK FOR 1914"

VERY few recordings will be used in "Scrapbook for 1914," when this, one of the most memorable of Leslie Baily's programmes, will be heard again on August 4th by listeners on the National wavelength. The year that saw the opening of the European War will be relived in the studio by many people who actually played a prominent part in events of the time. They will include Admiral Sir William Goodenough, who was present when two British naval squadrons visited Kiel, as guests of the Kaiser, in June, and the Countess of Oxford and Asquith, who will recall the anxious hours in Downing Street when her husband, as Prime Minister, was awaiting Germany's reply to the ultimatum. The "Scrapbook" will end with an eye-witness account by Charles Brewer, the B.B.C. producer, of the amazing Christmas truce which stopped hostilities for a few hours on sections of the French front in December, 1914.

FROM ALL QUARTERS

Are Britons Consistent Listeners?

MR. CESAR SAERCHINGER, who has just returned to America after acting as the Columbia Broadcasting System's representative in Europe for a number of years, puts forth some interesting views on English listening in the American magazine, *Atlantic*. He says: "I have come to feel that the English public, even if it does not listen as much as the Unseen Audience in America, listens more systematically, more discriminatingly, and more intently. Cultivation of listener habits and regularity of programming are two secrets of the B.B.C.'s success. Artistically, the B.B.C. has the best-balanced broadcasting schedule in the world."

Re-enter the "Proms"

ON August 6th Sir Henry Wood conducts the first of forty-nine concerts constituting the "Proms" season for 1938, all under the same baton. The occasion also marks the jubilee of Sir Henry Wood's first public appearance as a conductor. No technical changes have been carried out in the Queen's Hall for the new series. As usual, ribbon microphones will be used, and as often as possible only one instrument will be in circuit, although another may sometimes be brought into play for solo items.

New Studios for Schenectady

WGY, the General Electric station in Schenectady, last Saturday used for the first time its new five-studio headquarters. Quite recently this 50-kW station, which works on 790 kc/s (380 metres), was equipped with a new 625-foot vertical mast radiator.

Opening of A.I.R.'s Calcutta Station

TRANSMISSIONS will begin on August 16th from the new short-wave station, VUC2, of All-India Radio at Calcutta with a power of 10 kW. The approximate times of transmission are 8 to 10 a.m. (B.S.T.) on 9,530 kc/s (31.48 metres), and 12.30 to 6 p.m. (B.S.T.) on 4,880 kc/s (61.48 metres).

Commercial Broadcasting Pioneer Honoured

CAPTAIN LEONARD PLUGGE, M.P., who was a pioneer of broadcasting for British advertisers on the Continent and is chairman of the International Broadcasting Company, controllers of Radio Normandie and other commercial broadcasting stations, has been created a Chevalier of the Legion of Honour.

A Growing Child

IT is not only the B.B.C. which has built a Broadcasting House too small for its requirements, for AVRO, the Dutch broadcasting organisation's headquarters, which were completed last year, have apparently been found too small, for a new giant studio is to be built some distance from the head offices, which will be reached by a subway.

Suppressing Interference—N.R.E.A. Central Meeting

ALL engineers are cordially invited by the National Radio Engineers Association to a meeting which is to be held on Wednesday next, July 20th, at 8 p.m., at "The Orange Tree," Euston Road, London, N.W.1 (corner of Gower Street and opposite Euston Square tube station), when a lecture-demonstration will be given by Mr. Walters, of Belling and Lee, on the suppression of interference.

The Path of Least Resistance

DURING the recent severe storms, which have been experienced all over the country, several wireless aerials have been struck by lightning, whilst one struck in Derby caused a fire. This should be a reminder to us all to look to our aerial earthing arrangements to ensure that, if ours is struck, the charge will have an uninterrupted path to earth without damage to receiver or home.

Conductor to State Governor

HIS popularity as a broadcast jazz band conductor is apparently the chief plank in the platform of Mr. John MacPherson, who has put himself forward as candidate for the governorship of Texas. His first electoral address was given during one of his broadcast concerts. In America anything is possible!

Radio Barcelona

THE English announcer of Radio Barcelona, Mr. T. Powell, was killed recently during an air raid on the town.

Developing a High-Quality Communication Receiver

How a Receiver is Designed—XVIII

THE BEAT-FREQUENCY OSCILLATOR

IN previous articles in this series the chief details of the IF amplifier have been dealt with, and the question of the beat-frequency oscillator is now discussed. The matter is quite straightforward except for certain coupling difficulties which are treated in detail.

NOW that the general principles of the intermediate-frequency amplifier have been discussed and we have seen how we intend to obtain amplification and selectivity, it is necessary to deal with the beat-frequency oscillator. This is included primarily in order to permit CW morse reception, but it has other uses. If it is kept in circuit while searching for a weak telephony station, for instance, it is very much easier to find that station because the beat between its carrier and the oscillator produces a whistle which is easily heard. When the station is tuned in, of course, the oscillator is switched off. One thing should be made clear; the BFO does not enable one to obtain any better results on telephony. What it does do is to make it easier to *find* very weak signals.

The oscillator must be tuned to a frequency very close to the intermediate frequency of 465 kc/s. The exact frequency is not important, but would usually be 464 kc/s or 466 kc/s, so that an audible beat of some 1,000 c/s is obtained. There is nothing difficult in the oscillator itself, and basically all we need do is to provide an oscillator capable of being adjusted to a frequency close to 465 kc/s and to provide it with an on-off switch. The simplest course is to include a make-and-break switch in the HT lead to the valve. The use of any old oscillator is likely to be unsatisfactory, however, for it is essential that its output be coupled into the receiver where it is wanted and nowhere else.

Coupling Receiver and Oscillator

With a haphazard arrangement considerable injection into the early IF circuits may occur and cause valve overloading in the later stages. Furthermore, harmonics of the oscillator may be picked up by the RF circuits and beat with the frequency-changing oscillator to cause a multitude of howls and squawks.

In spite of their apparent simplicity the circuits of the BFO must be carefully designed if the performance is to be satisfactory. The primary requisite is good screening. Both valve and coils must be well screened, so that in the absence of intentional coupling it is hardly possible to detect whether the oscillator is working or not. Coupling of the correct degree to the desired point of injection must then be provided.

The oscillator output can then be injected into any IF circuit prior to the detector, but it is usually advisable to make the point of injection the coupling between the last IF valve and the detector. This results in a maximum of coupling and so avoids the practical difficulty of providing a controllable coupling which is very loose indeed. Furthermore, the detector input from the BFO is constant irrespective of the gain of the IF amplifier. If injection were arranged in an early stage the amplitude at the detector would vary with changes in IF gain to accommodate signals of different initial strength. Moreover, this would result in a strong BF oscillation at the detector for a weak signal and vice versa, which is the reverse of what is required.

Coupling to the detector results in a constant amplitude of beat-frequency oscillation. This is not perfect, but is in practice very satisfactory. The amplitude is by no means critical provided that it is stronger than that of the signal. If it is too great, however, it results in a marked loss of strength on weak signals, especially if AVC is kept in circuit. If it is too weak results are good on weak signals, but the correct beat is not secured on very strong signals. Some compromise is obviously needed, and as the advantages of a beat-frequency oscillator are most marked in the case of weak signals, the coupling should tend to be on the weak side rather than too tight.

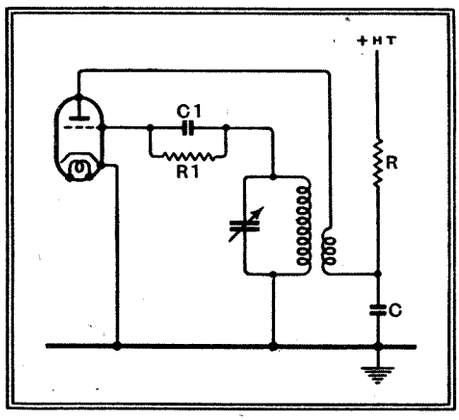


Fig. 15.—The reaction-coil oscillator with a triode valve is one of the simplest arrangements.

Almost any type of oscillator can be used, and our choice will depend chiefly upon the ease with which we can obtain the requisite degree of coupling. The simplest arrangement is probably the simple tuned-grid triode oscillator of Fig. 15. Coupling can be arranged by connecting a condenser between the grid and the high-potential end of the tuned circuit used for the detector intervalve coupling. This has certain disadvantages, however, chief among which is a tendency for the intermediate frequency to pull the oscillator into step with it. This is almost inevitable with this type of coupling for it is "reversible"; that is, not only can the oscillator output be fed to the detector, but the signal input to the detector can be fed to the oscillator, and it tends to make the oscillator function at the same frequency as the signal. This limits the beat notes obtained to fairly high frequencies.

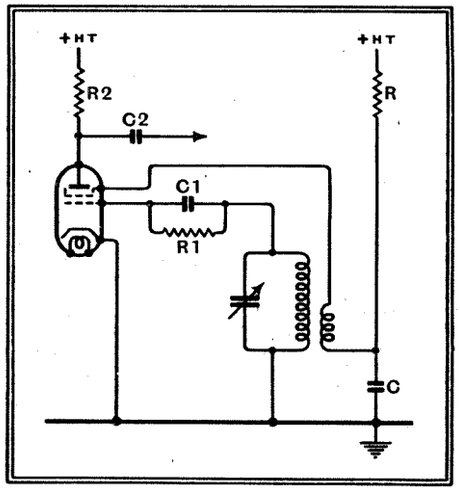


Fig. 16.—A screen-grid valve can be used with the screen and control grids as the oscillator electrodes and the output taken from the anode. Valve capacities prevent this from giving freedom from unwanted couplings.

The obvious thing to do is to use a screen-grid valve as an electron-coupled oscillator, and the basic circuit is shown in Fig. 16. The control grid and screen grid form the grid and anode of a conventional triode oscillator, and the output is taken from the anode by means of a resistance-capacity coupling R2 C2. In practice R2 would be of moderate value and C2 very small. This is done to obtain "one-way traffic" between the oscillator and the detector. Since oscillation takes place between the inner elec-

High-Quality Communication Receiver—

trodes the electron stream is modulated, and oscillator frequency potentials appear across the coupling resistance R2. Signal

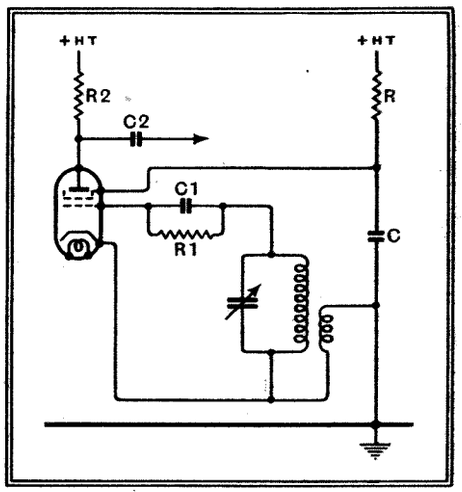


Fig. 17.—By changing the circuit round as shown here the screen-grid can act as a screen between grid and anode and good circuit isolation results. This is the electron-coupled oscillator.

potentials can, of course, also appear across this resistance, for they will be passed by C2, but variations in anode potential have a negligible effect upon the oscillator itself.

Actually, this particular circuit does not function quite in this way on account of the inter-electrode capacity between the screen-grid and the anode. To obtain a closer approach to the correct results it is necessary to rearrange the circuit as in Fig. 17. Here the screen is earthed through C and the cathode is live. As the screen is earthed the screen-anode capacity no longer acts as a coupling condenser, and a much closer approach to the desired one-way action is secured.

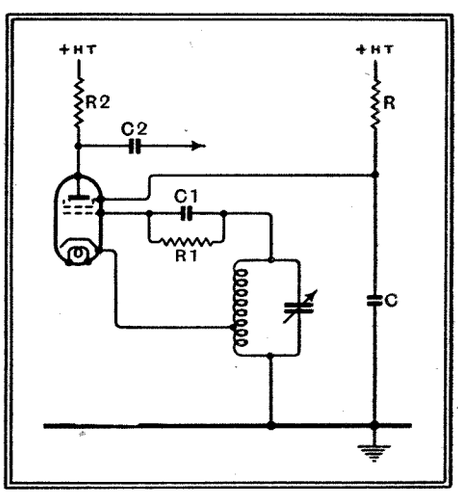


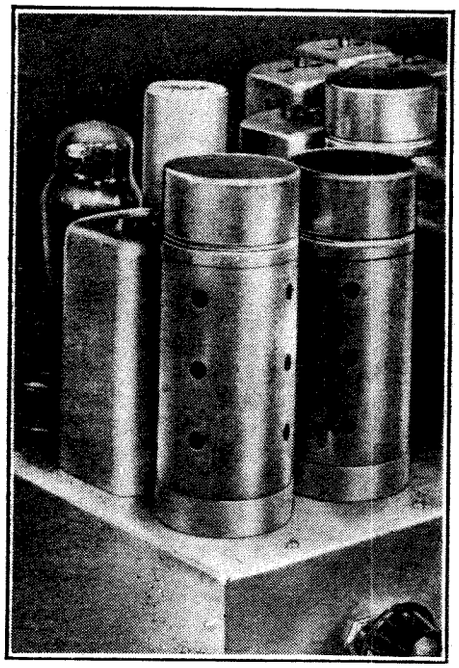
Fig. 18.—The Hartley circuit is simpler than the reaction-coil type in an electron-coupled oscillator.

Again it is not perfect, however, partly because the coil between cathode and earth is in the complete external anode-to-cathode circuit and partly because of the anode-cathode valve capacity. This is fairly small, however, and the results with this circuit are quite satisfactory in practice.

With this electron-coupled arrangement the reaction coil oscillator is no longer the most convenient, and it is simpler to use the Hartley circuit as in Fig. 18. Only one tapped coil is needed, and one side of the trimmer can be earthed. This then represents the final beat-frequency oscillator circuit. The type of valve used is not very important and circuit values are best chosen experimentally. In general a valve such as the KTZ63 or 6J7 can be used with R1 and R equal to 50,000 ohms; C1 can be 0.0005-0.001 μF. and C about 0.1 μF. R2 and C2, however, must be chosen by trial and error, since it is almost impossible to predict the values needed.

As already mentioned, a switch must be provided to break the oscillator anode circuit when the BFO is not needed. The question of AVC still requires consideration, however. When the oscillator is used for morse reception, AVC is unnecessary, and in fact disadvantageous. The time-constant of the AVC circuit prevents its responding immediately to the dots and dashes of the morse code, but of much greater importance is the fact that the AVC bias is governed largely by the detector input from the BFO and not by the signal. This means that the AVC bias is substantially constant and is not dependent on signal strength.

When using the BFO, therefore, AVC must be cut out of circuit, and this is most



Adequate screening of the oscillator is secured if the coil assembly is screened and the valve has a metal can over it. The parts must be placed close to the detector.

easily done by means of a switch in shunt with the main filter condenser in the AVC line. This switch can be conveniently linked with the BFO on-off switch so that a single control gives a change-over from BFO on and AVC off to BFO off and AVC on.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Empire Reception

I HAVE delayed until now replying to Mr. Elliot's comments from Canada on my article, "Return from Malaya," in case there should have been further comment from other Empire listeners.

It is gratifying to know that the B.B.C. system for the collection of reports from listeners in Canada is so satisfactory. I can only speak from what has come to my personal knowledge in Malaya, and there I know technical listeners who have long since ceased writing to the B.B.C. They have found it difficult in the past to make contact with the Engineering Division owing to their letters apparently being dealt with by a clerical staff who hand out stereotyped replies. I made a special exception of the array tests, which continued over an extended period and during which all listeners were asked to report on a series of definite comparative tests. I am still of the opinion that even better results could be obtained from the Empire Service if the B.B.C. were to employ their own staff on reception tests, as I suggested in my article.

When I said that Transmission II is intended for Malaya, I referred to the programme material and arrangement, and particularly to the time of the News Bulletin. Transmission III (for India) is, of course, directional on Malaya, and, as I said, very well received, but the news is not read until nearly midnight, Malayan time.

I remember the R2 to zero days of Empire reception in Canada, when I was living there in 1930 and 1931. I am very pleased to hear there has been such a vast improvement.

As to American sets, I must make it really clear that I was not referring to sets of the luxury class, such as the Scott and Silver, when I said that the success of Empire broadcasting in Malaya had been built on a solid foundation of American receivers. The sets which are so widely used there are the standard American export types made by manufacturers such as Philco, R.C.A., G.E. of America, Crossley, and Westinghouse. They are of the class which sells at about $60 in U.S.A. No British set sold at £12 or even up to twice that price could give a comparable performance under Empire conditions. I am sure even the G.E.C. would not agree with Mr. Elliot in placing their Fidelity Eight in the same class as the luxury American sets. Its specification and performance are similar to the standard American export types.

I am afraid Mr. Elliot has missed my point about Empire programmes, perhaps because it was necessary to curtail this part of my article for publication. I agree that the programmes compare favourably with other short-wave programmes, as he states, but it cannot be denied that the Empire programmes are inferior by a very wide margin to the B.B.C. Home programmes.

The best items of the Home programmes are only radiated during the period of transmission which coincides in time, usually

Transmission IV. All other periods are filled mainly by the matter originated by the Empire Programme Department. Usually each item is given in original in one period of transmission only and electrically reproduced in the other periods.

It is often asked by listeners that if recordings of the Empire Department's own programmes have to be used, why cannot recordings be made of the Home evening programmes, which are so much better? The B.B.C. answer is that they must pay the same fee for broadcasting a recorded programme as they have to pay for the original. A solution ought to be found to this difficulty; some arrangement should be made so that a fee paid by the B.B.C. covered performance to all its listeners, including the Empire. The continuance of the Empire Programme Department in its present form should be regarded as a compromise until the best B.B.C. programmes can be given to the Empire.

"HEPTODE."

Ekco Receivers

IN paying tribute to the ingenuity of the automatic wavechange mechanism of our new PB.289 motor-operated press-button receiver, your contributor, "Diallist," in your issue of June 30th, is in error in one respect regarding the claims which are made on behalf of the receiver.

Versatile as it is, it will not automatically tune in individual short-wave stations, in fact on short waves the automatic station selection device and AFC are switched out of circuit. For short-wave tuning, the "cruising" buttons enable the motor to be used for moving quickly and silently between short-wave broadcasting bands, but short-wave station tuning must be done manually. The wavechange mechanism however, will tune in automatically any selected station on medium or long waves, even if the wavechange switch has been left in the short-wave position.

E. J. WYBORN.
Chief Engineer E. K. Cole, Ltd.
Southend-on-Sea.

Receiver Guarantees and Service

I SEE that "Diallist" has returned to the attack about manufacturers' guarantees and service.

May I suggest that if he answered the following questions and then considered those replies in relation to selling prices and the state of the radio trade, it would do much to clarify his mind on these matters:

(1) Having regard to the low profit obtained per set sold by the manufacturer to the dealer, what manufacturers' guarantee would "Diallist" suggest?

(2) Having fixed the terms and generous conditions, who is going to pay for the service guaranteed? If the answer in this case is the manufacturer, where or from whom is the manufacturer going to get the money?

(3) What authority or body should force, or persuade, manufacturers into a common guarantee?

(4) When, through economic pressure or sales necessity, a manufacturer alters his guarantee policy (all above-board, after having given due notice, etc.), who is going to stop him?

(5) If the manufacturer finds that there is a demand for his sets in, say, Barchester (a fictitious town) and he cannot find a technically competent agent or an agent with a competent radio engineer employed, what should the manufacturer do?

The gracious act of paying for carriage on sets with silly little breakdowns, as well as the time of engineers, mechanics, and staff to receive, record, and correct them, depends upon answer 2.

I suggest (as I did in the *Wireless World* of 19th March, 1937) that "Diallist" should spend two or three weeks in the offices of a manufacturers' service department or that of a large store.

He would be forced to the obvious conclusion that the public gets what it pays for.

If the public refuses to pay for service when it buys the set (I don't believe it does, personally, but dozens of manufacturers surely *can't* be wrong) then it pays for it afterwards.

"ALTER EGO."

Muffled Broadcasting

IN reply to your correspondents, H. S. Saxton and M. Mistovski, who wrote in your issue of June 30th criticising adversely my letter of June 9th on the subject of "Muffled Broadcasting," I had better make clear at the outset one or two elementary points concerning myself and my listening apparatus.

1. I have excellent hearing.
2. Since 1929 I have had various sets.

There has never been a time, since I started listening-in (pardon an old-fashioned term!) up to the present day, that I have not felt frequently dissatisfied with reception from home stations, and I have not been in the same locality during the whole of this period, but have listened at various places, widely separated from one another.

It would be indeed a strange coincidence if all my various receivers, of differing makes, suffered from a deficiency in their high-note response, as Mr. Saxton suggests may be the cause of my dissatisfaction, or that they all were subject to overheating, which is a suggestion of Mr. Mistovski. Especially as in the case of the latter supposition the one thing my receivers have had in common is that they were all *battery*-operated!

My present set is a Pye 15-guinea model QP.B, new this year, and is in perfect condition. I have often noticed that, while an orchestral broadcast may be of excellent quality and balance of tone, the announcer proclaiming the next item to be played may himself sound miles away.

T. J. E. WARBURTON.
St. Leonards-on-Sea.

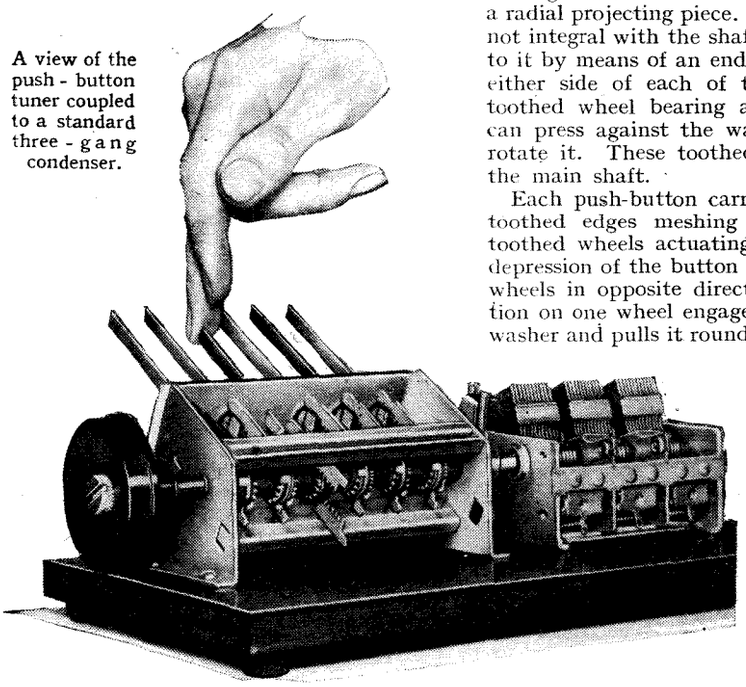
Home Laboratory

IN my recent series of "Home Laboratory" articles I made more than one reference to the absence of a "tuning indicator" with a short grid base of about 4 volts and an indication of the closing sector type, suitable for laboratory apparatus such as the valve voltmeter or C and R bridge. My attention has been called to the Tungsram ME4S, which is similar in every way to the Mullard TV4 except that the indication is a closing sector instead of a spreading cross.

M. G. SCROGGIE.
Bromley, Kent.

Oak Mechanical Tuner

MARKETED in this country by The British N.S.F. Co., Ltd., of Waddon Factory Estate, Croydon, Surrey, the Oak Mechanical Tuner is of the push-button type, giving also a direct drive. It is at present available only to manufacturers.



A view of the push-button tuner coupled to a standard three-gang condenser.

The tuner is intended for use with a standard gang condenser and consists of an arrangement whereby the depression of a push-button mechanically operates the gang condenser and rotates it to the desired position. Electrically, therefore, a receiver incorporating it differs in no way from a conventional type.

There are six push-buttons and the driving shaft carries six washers, each with a radial projecting piece. These washers are not integral with the shaft, but are clamped to it by means of an end-locking screw. On either side of each of these washers is a toothed wheel bearing a projection which can press against the washer projection to rotate it. These toothed wheels rotate on the main shaft.

Each push-button carries two arms with toothed edges meshing with the pair of toothed wheels actuating one washer. The depression of the button rotates the toothed wheels in opposite directions. The projection on one wheel engages with that on the washer and pulls it round with it, and hence the condenser shaft, until it meets with the projection on the other wheel. The washer projection is then locked between the wheel projections.

To set up the tuner it is necessary only to slack off a locking screw, depress the button for the station required, and then to tune in that station by the control knob. Six stations can be done in this way and the tightening of the locking screw then finishes the process.

What is a Valve?

By R. W. HALLOWS, M.A.

A WAY OUT OF THE PRESENT CONFUSION

WHEN broadcasting was young we knew exactly what a valve was. It was an assembly of three electrodes (filament, grid and plate) in an evacuated bulb, and it had only three possible functions: it could detect, it could amplify, it could oscillate. A receiver described as a four-valve set was something as clearly defined by its title as a four-pronged fork or a four-wheeled vehicle. It could and did contain neither more nor less than four triode valves, three of which amplified at radio or audio frequency, whilst the fourth detected, oscillating as well if we were receiving continuous-wave signals or indulging in the nefarious practice ("Will listeners in the neighbourhood of the Market Place, Little Pigley, kindly look to their sets?") of tuning in broadcast transmissions by the squeal.

Everything in fact was plain sailing until the AC mains set made its appearance. The newly introduced rectifier was the little cloud on the horizon that foretold, had we but known it, the storms that were to rage in years to come over the question of what might or might not properly be numbered as a valve in the description of a radio set. The block circuit of Fig. 1 (a) clearly represents a four-valve set; that of Fig. 1 (b) is exactly the same thing, except that the HT and LT current comes not from batteries but from the mains *via* the rectifying valve. If (a) is a four-valve set, is (b) a five-valve set? And if not, why not?

A few set-makers, out to make every possible selling point, leapt at the chance of reckoning in an extra valve; but the majority bowed to public opinion, which was that, though the rectifier was unquestionably a valve, it ought not to be counted in the descriptive number, since it had nothing to do with signals on their way from aerial to loud speaker. The practice of describing a set with a Fig. 1 (b) circuit as a four-valve plus rectifier receiver, though obviously fairer than calling it a five-valve receiver, has unfortunately not been adopted even yet by all makers: there are some who still count in the rectifier, though its work can be done by the Westinghouse copper-oxide device, which no one seems to call a valve.

SO long as power rectifiers, tuning indicators (and even barretters!) are classified as valves by some makers and not by others, the present fashion of rating broadcast receivers by number of valves can lead to nothing but confusion. The rating system suggested in this article is both informative and easy to understand by anyone who takes the slightest interest in the technicalities of his set.

The muddle over the rectifier was (and still is, to some extent) a nuisance, but it had no important effects, for intending purchasers of wireless sets soon learned enough to ask "Does that include the rectifier?" when shown an alleged three-, four- or five-valve receiver. So long as the straight receiver was the only one in general use and so long as there was no valve more complicated than the pentode, all was well. Every valve performed its own special function; all the valves of a set were, so to speak, in the direct line between aerial and loud speaker; each did something to the signal itself and helped it on its way. In those days we could say definitely that a four-valve set was superior to a three-valve set, and that a five-valve set was better than either. More valves meant more stations. Naturally, then, we came to regard the number of its valves as a fair indication of the performance to be expected from the receiver.

Early superhets introduced no great difficulties. In Fig. 2 (a) is the circuit of the kind of superhet that some of us were using about six years ago. It contains eight valves, of which six are in the direct aerial-loud speaker line. We had no qualms about including the oscillator in the number of the valves, though what was then known as a combined detector-oscillator could be used; and when AVC came we had no doubts about counting the separate valve that it needed in those days, for this acted directly on the signal and kept it steady. No one, I think, would have felt any twinges of conscience about describing such a set as an eight-valve receiver.

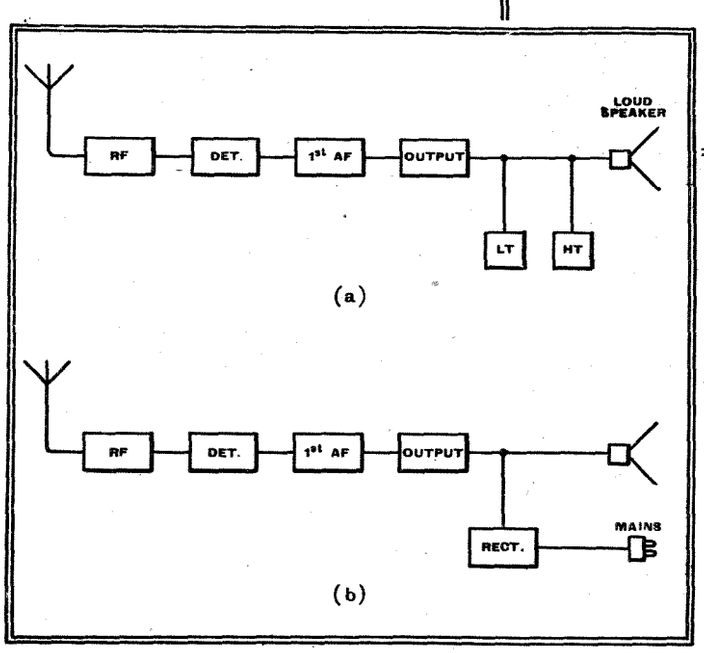


Fig. 1.—How it all began. (a) is a 4-valve circuit; is (b) a 5-valve circuit?

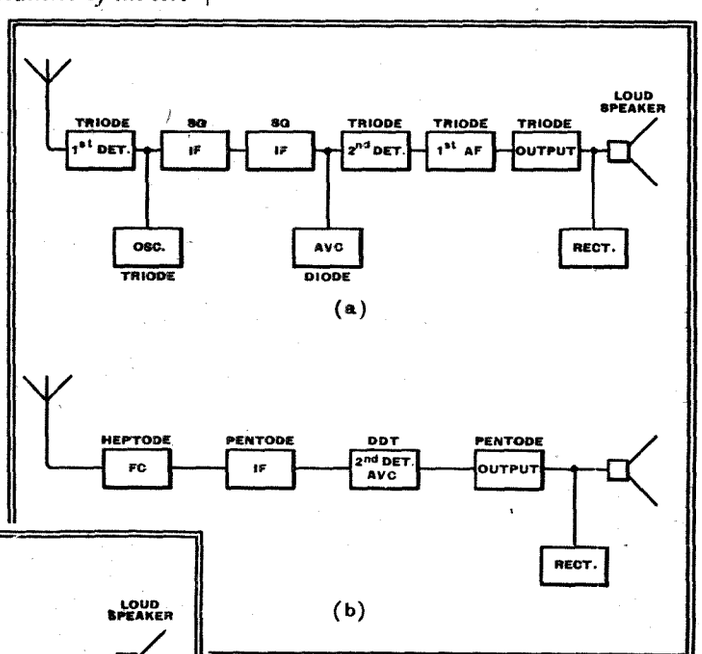


Fig. 2.—More complications! (a) is undoubtedly an 8-valve set made up of simple valves; is (b), which may be more sensitive, have bigger overall magnification and produce greater volume, a 4-valve set?

What is a Valve?—

Then the multi-electrode valve, doing two or three duties at once, was developed and at once controversies arose. Some makers were using mainly single-purpose valves; others plumped for the more complicated types. One firm's four-valve set, with a circuit such as that seen in Fig. 2 (b), might be a better station-gatherer than another firm's containing far more valves. For a time there was considerable confusion and great argument. But eventually all makers adopted the multi-electrode valves, and when a man asked for a four-valve superhet he expected to be supplied with a set whose circuit was either that of Fig. 2 (b) or some variation on the same theme.

Once more we knew where we stood: once more the valves numbered in a set's description meant those in the aerial-loud speaker line. A five-valve set would probably have a signal-frequency amplifier; it was more sensitive and more selective than a four-valve receiver and less prone to create its own interference by producing second-channel whistles. More valves again meant more stations or more volume.

Complications Set In

But not for long! All kinds of uses were found for valves outside the direct aerial-loud speaker line, and to-day the total number of a superhet's valves is not necessarily any criterion of its sensitivity or its overall amplification. Glance at Fig. 3, in which I have shown how five undeniable valves can be added to the Fig. 2 (b) circuit without making the slightest difference to these qualities. Two are used for automatic frequency control; there is a separate oscillator and an oscillator amplifier; instead of a single output valve, two are used in push-pull.

Can this be called a nine-valve set? I say yes, with certain qualifications, to which I shall come in a moment, because each of the four valves that are off the aerial-loud speaker line and the fifth in double harness with the output valve unquestionably improves performance. The separate oscillator and its amplifier make the set less prone to creeping; the two AFC valves automatically ensure correct tuning; push-pull output means better quality of reproduction.

Some makers would class this as a ten-valve set, counting in the cathode-ray tube tuning indicator used when AFC is not in operation. Others would reckon the valves as eleven by including the rectifier. Neither of these courses is justifiable. Though the rectifier is certainly a valve and the tuning indicator may include a three-electrode assembly, neither has any effect on the signal, and its work could be undertaken by something that is certainly not a valve—a Westector in the one case, a milliammeter in the other.

The Americans have been blamed for the present confusion; it has been said of them that they count in everything that they possibly can, rectifiers, tuning indicators and even barretters. They do. But they don't call them valves. Such things (with the possible exception of barretters) are quite rightly described by them as tubes, a word that covers any evacuated or gas-filled bulb through which an electron stream flows from cathode to anode. They have no word with a special radio significance such as our valve. We adopted that rather stupid word originally as a name for the Fleming diode, because its unidirectional handling of an electron stream suggested a parallel with the air-valve, the water-valve and the steam-valve. It has stuck ever since, and since it will probably go on sticking we shall have to make the best of it.

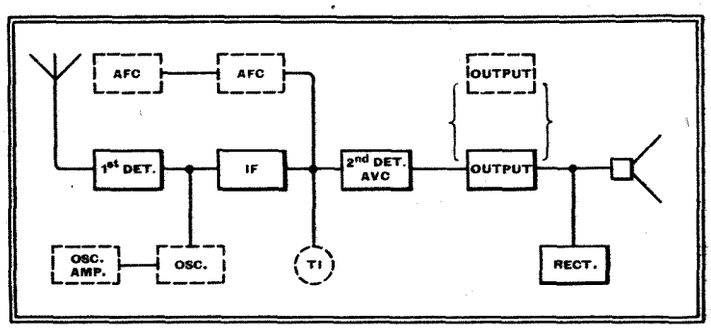


Fig. 3.—The basic circuit is the same as that of Fig. 2 (b); but though the set has the same four-valve sensitivity and overall magnification it might be described by different makers as a nine-, ten- or eleven-valve receiver.

What we clearly need is some brief description of a set that will indicate both its station-getting powers and the refinements introduced by valves that have no direct amplifying or detecting effects on the signal. Ekco have adopted the "stage," but I hardly think that our purpose is fulfilled by a description such as "an eight-stage, four-valve receiver." Could you say off-hand exactly what a "stage" is?

My suggestion is this: the tuning indicator and the rectifiers should always be excluded; a set should be described by the number of the valves in the direct aerial-loud speaker line that form its *base*, and by the total number of valves as well. Thus I would call the Fig. 2 (b) set a "four-base, four-valve superhet," and that of Fig. 3 a "four-base, nine-valve superhet." A receiver with SF stage, FC, 2 IFs, detector, 1st AF, push-pull output and rectifier, which included separate AVC valves for IF and SF, 2 AFC valves, a beat oscillator, a cathode-ray tuning indicator, and a squelch valve would be known as a seven-base, fourteen-valve superhet.

This system would seem to fit the bill exactly. The purchaser of a four-base, four-valve set would know that he was getting a receiver with four-valve sensitiveness and overall amplification, but without any frills. He could see from its descriptive title that if he went in for a four-base, nine-valve receiver he could expect much the same sensitivity and selectivity, and therefore about the same number of stations, but owing to the refinements supplied by its additional valves he would receive those stations better than with the smaller set. The superiority of the seven-base, fourteen-valve set to either is instantly obvious. It is clear that it has three more valves in its basic aerial-loud speaker line, which means increased sensitivity and selectivity and more volume; the presence of seven other valves shows that it has many refinements (the details of which the prospective purchaser will at once become eager to discover from the full specification) which must make for greatly improved all-round performance.

The strong points of the suggested system are that it is applicable to all receivers; that it is fair to both manufacturer and purchaser; that the descriptive title, though brief, *does* describe, and that the probable performance of any set is immediately clear from its title. Were all manufacturers to adopt it there would be an end to confusion—but will they?

On the Short Waves

"THE work of amateurs and experimenters has always been important to radio progress. This is largely because many amateurs are highly endowed with a Missourian point of view and a driving curiosity which leads them to prefer the byways and the unknown regions of their hobby rather than the beaten paths.

"Even though the individual findings of many in this group are small, the total contributions and accumulated experience of all the radio amateurs and experimenters in the United States have been impressive."

The above is taken from an article on "Television Cathode Ray Tubes for the Amateur," by R. S. Burnap in the R.C.A. Review for January, 1938, and in my opinion is one of the neatest statements I have ever read on the subject of the amateurs' contribution to radio art.

From this extract it is only a short way to the R.S.G.B. five-metre field-day—which is dealt with more fully elsewhere—and which this year was particularly interesting. During the course of this Sunday one managed to visit two of the portable stations, G2NHP at Polesden Lacy and G2JKP near Tattenham Corner, Epsom Downs. Two more distant stations, G2NMP near Arundel and G5MAP near Alton, were contacted later in the day (but not visited), QSA5 R8 'phone signals were exchanged in both cases, G2NMP being 37 miles and G5MAP 35 miles distant, respectively.

The transmitter used by G2NM was relatively stable, but not quite as good as the

On the Short Waves—

crystal-controlled transmitters used by G5MA and G2NH.

The success of this five-metre field-day raises the question of—will the R.S.G.B. find it necessary next year to run a 2½-metre field-day—the licensing authorities, of course, co-operating?

In this connection I must thank G8SK for his note pointing out that G5VY and G6JI have been testing on 2½ metres for over 2½ years now, and obtain QSA5 R7/8 signals over 6½ miles in a fairly densely populated area.

Driven transmitters and superheterodyne receivers are now used, and G8SK has now joined G5VY and G6JI to make a three-way network. The various aerials used have in all cases been inside the room housing the apparatus.

A series of tests have also been made on 1¼ metres, G8SK states, with a fair degree of success.

Incidentally, one is always pleased to receive details of this kind and, whenever possible, appropriate reference will be made in these notes.

I have no cronies and have no desire to form an Ethacomber five-metre clique—although the accusation that I look after my ice-skating friends G5MA and G3CU *was* levelled at me by G2NH!!

Remaining on the subject of 2½ and 1¼ metres, it is interesting to record the production by R.C.A. of a new beam self-contained push-pull tetrode giving an output of 10 watts on 1¼ metres with only 500 volts on the plates in a classical amplifier circuit. I would very much like to know if any of these new tubes have reached this country yet?

They are certainly going to open up the way to really well-designed transportable 1¼- and 2½-metre crystal-controlled transmitters of considerable power.

Short-wave conditions remain good, in fact excellent from the short-wave broadcasting point of view, with the possible exception of Friday, July 1st, when there was a slight ionosphere storm following a "Dellinger" fade-out at 11.30 a.m. on Thursday, June 30th. There was a further short period fade-out on Friday evening.

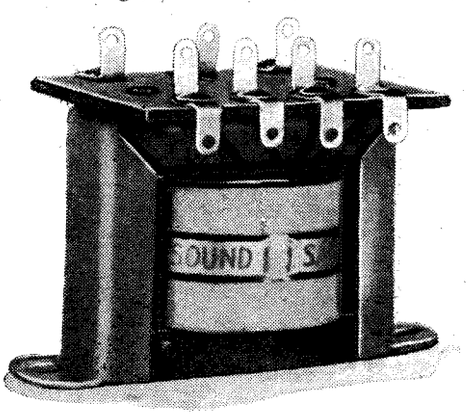
Good reception of the Berlin sound transmissions on 42 Mc/s has also been reported, and this station was particularly good, *i.e.*, full loud speaker signals with negligible noise just before 11 p.m. on Tuesday evening, July 5th. No abnormalities were noted in the 56 Mc/s band at this time; however.

Finally, I believe that from time to time five-metre transmitting amateurs have found that, in order "to get over" the brow of a hill from the valley successfully, it is necessary to use horizontal polarisation. The results of some tests between my station in the valley at Epsom and G2OD over 18 miles of practically dead flat country, and also with G2MV, whose station is out of sight behind Epsom Downs, may be of interest. After a series of checks to determine that the aerials were radiating and receiving only plane polarised waves, it was found that there was no detectable difference between vertical and horizontal polarisation between G2OD and my station. From G2MV, however, although either vertically or horizontally polarised waves could be received at my location with equal facility, G2MV, whilst obtaining very strong signals from my station when the aerial was horizontal, could only receive very weak and fluttery signals when the energy was vertically polarised. It is important to note that G2MV's site is 600ft. above sea-level and has a clear "getaway." The line of sight, however, to my aerial passes some 200ft. below the top of Epsom Downs, which rise to a height of some 500ft. within a mile of my transmitter. I believe this confirms the experience of G5RD and others. In other words, the law of reciprocity does not always hold, and "to climb over a hill" on five metres successfully it is necessary to use horizontally polarised waves.

ETHACOMBER.

Sound Sales Transformer

A COMPONENT of special interest to those who wish to use the new 6.3-volt valves with a transformer having only 4-volt windings, or who want to use a mixture of 4-volt and 6.3-volt valves has been produced by Sound Sales, Ltd., of Marlborough Road, Upper Holloway, London, N.19. It is a transformer with a 6.3-volt secondary and a 4-volt primary.



Sound Sales 4-volt—6.3-volt transformer.

With a component of this nature the precise secondary voltage depends not only on the secondary current but also upon the primary voltage, which is likely to vary somewhat in different receivers according to the voltage drop in the heater wiring. The primary is accordingly tapped and with a 4-volt input connected to terminals A a secondary current of 1.8-3 amps. can be obtained. With the 4-volt connections made to terminals B, a secondary current of up to 1.5 amps. is catered for.

The transformer can, of course, be used backwards if desired; that is, to give a 4-volt output from a 6.3-volt source. This is often convenient in experimental work.

The transformer is nicely finished and at 7s. 6d. can confidently be recommended.

BROADCAST PROGRAMMES

Features of the Week

THURSDAY, JULY 14th.

Nat., 7.10, Carroll Gibbons and the Savoy Hotel Orpheans. 9, The Western Brothers in "Cads' College."

Reg., 7, Week-end Walks in London; II—Charing Cross to St. Paul's. 8.25, The Summer Revellers; a concert party relay from Newquay. 9, Celebrating the opening of the Birmingham Hospitals Centre. 9.50, The Prime Minister and the Birmingham Centenary Banquet.

Abroad.

Munich, 7.10, "Frederica," operetta (Lehár).

Naples Group, 9, "Francesca da Rimini," opera (Zandonai) from Cremona.

FRIDAY, JULY 15th.

Nat., 4.15, International Bowls Tournament: Wales *v.* Ireland. 8.15, Stanelli's Bachelor Party, No. 18. 9, "The Fall of an Empire"; radio chronicle of events prior to the Franco-Prussian War.

Reg., 6.20, "Come on and Dance": Jack Jackson and his Band. 9, Ken Johnson and his West Indian Orchestra.

Abroad.

Frankfurt, 8.15, Johann Strauss Concert.

Paris PTT, 8.30, Symphony Concert from Vichy Casino.

SATURDAY, JULY 16th.

Nat., 3.15, Commentary on the final stages of the competition for the King's Prize, at Bisley. 3.45, Village Cricket: Little Dunmow *v.* Hatfield Heath. 4.20, Amateur Athletic Association Championships at the White City. 8.30, A Scotsman in the French Revolution. 9.40, The Last Voyage of Captain Grant, second instalment of serial.

Reg., 6, Eugene Pini and his Tango Orchestra. 8, "The Invisible Man," a Father Brown story by G. K. Chesterton. 8.30, Sing-Song, a Saturday night entertainment.

Abroad.

Sottens, 8.40, Bernard Shaw's play, "St. Joan."

Milan Group, 9, "The Barber of Seville," opera (Rossini) from Cremona.

SUNDAY, JULY 17th.

Nat., 1.30, Julius Kantrovitch and his Orchestra. 6.15, The Richard Crean Orchestra. 9.5, Jerome K. Jerome's "Three Men in a Boat."

Reg., 5, Troise and his Mandoliers. 6, "Benedicite omnia opera," an oratorio mosaic. 6.40, Forgotten Successes: II—"The Lights o' London," drama in five acts by George R. Sims. 9.45, The Birmingham Philharmonic String Orchestra.

Abroad.

Radio-Paris, 8.30, Anglo-French Concert by the National Orchestra and Raugel Choir.

MONDAY, JULY 18th.

Nat., 4, The United States Ambassador at Boston, Lincs, speaking during the annual visit of representatives from Boston, Mass. 7, The Bungalow Club. 8.10, "The Jade Claw," a play by Nicholas Sandys.

Reg., 6.25, Band of the Portsmouth Division of H.M. Royal Marines. 8.20, Twinkle Concert Party from Eastbourne. 9.20, London Symphony Orchestra from the Empire Exhibition.

Abroad.

Leipzig, 7, Caruso Memorial Programme.

TUESDAY, JULY 19th.

Nat., 7, Louis Levy production. 8.30, Aberdeen Nights: Third of the series of visits to seaside resorts.

Reg., 7, Your Visit to Scotland—Cottages and Castles. 8, Dave Frost and his Band.

Abroad.

Paris PTT, 1, Their Majesties The King and Queen arrive at Boulogne-sur-Mer.

Radio-Paris, 8.30, Entente Cordiale: special programme in honour of Their Majesties' visit.

WEDNESDAY, JULY 20th.

Nat., 5.20, The Grand Hotel, Eastbourne, Dance Orchestra. 8, Musical Comedy, "Sweet Dreams." 9, The Pageant of Radio; programme in memory of Marconi, 1874-1937.

Reg., 8.25, Ballachulish Slate—recorded impression of a famous quarry. 9, Northern Music Hall; relay from Birkenhead.

Abroad.

Paris PTT, 9.45, Their Majesties at the Opera.

Special IF Amplifier

BETTER ADJACENT-CHANNEL SELECTIVITY

By D. P. TAYLOR

INCREASING attention is now being directed towards the problems of noise suppression and to the finding of acceptable compromises between the requirements of selectivity and quality of reproduction. With the present allocation of medium-wave frequencies (and there appears no immediate hope of improvement), the response of a modern receiver should be as low as possible at frequencies more than 5 to 6 kilocycles removed from resonance in order to eliminate interference from stations working on adjacent channels.

The only exception to the above occurs when the receiver is designed for use on a carrier the level of which is high compared with those of transmitters on adjacent channels; i.e., for local-station reception.

In the interests of faithful reproduction the response should be as nearly uniform as possible over the range 5 kilocycles above to 5 kilocycles below the resonant frequency. This means that the overall response curve of the receiver should be approximately rectangular.

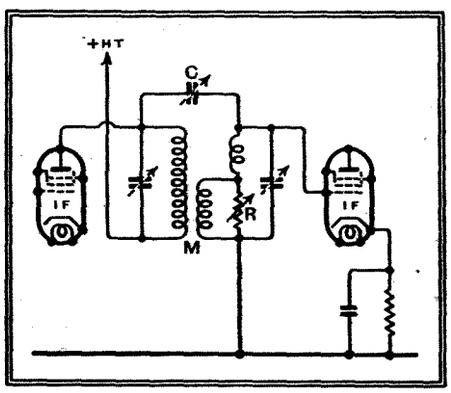


Fig. 1.—The IF circuit described employs mixed coupling by means of mutual inductance M and "top-end" capacity C. Values: R, 50,000 ohms; C, 25 m-mfd.

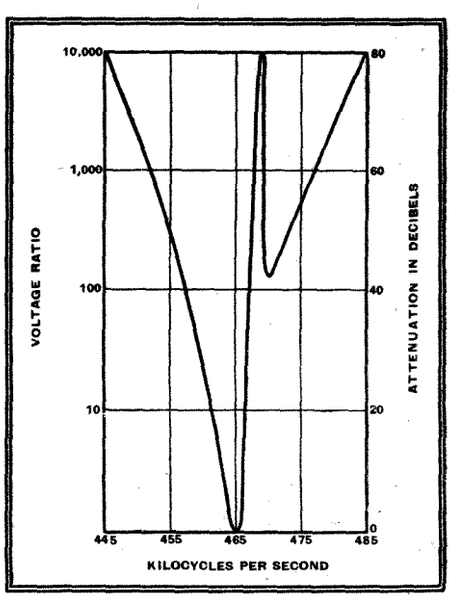


Fig. 2.—Response curve of IF stage with infinite rejection at + 5 kc/s from resonance.

The present means of obtaining high selectivity is to use a series of "High-Q" tuned circuits in cascade, usually in the intermediate frequency amplifier of a superheterodyne. This type of circuit has a response curve more nearly triangular than rectangular, and if the overall selectivity is made sufficiently great to eliminate adjacent-channel interference, then the upper side-bands of the desired station suffer severe attenuation and poor quality results.

A new type of IF amplifier of almost rectangular response has been developed in America in the R.C.A. laboratories, and tested in practical form by Miles and McLaughlin. The fundamental circuit is shown in Fig. 1; it will be seen that, in addition to coupling by mutual induction between the primary and secondary of the IF transformer, capacity coupling is also introduced by the use of the condenser C between the high-potential ends of the windings. The values of M and C are chosen so that at some frequency slightly removed from resonance, the voltage induced in the secondary through M is equal to that through C, but in phase opposition so that they cancel out.

To obtain a perfect balance power factor correction is necessary, and for this purpose the variable resistance R is used; this can be adjusted in the first place and then left untouched.

The response curve of an IF stage of this type, with the point of zero coupling set at 5 kc/s off resonance, is shown in Fig. 2.

Using Several Couplers

If a two-stage amplifier is used, two such couplers may be used, one being adjusted to reject at a frequency above resonance and the other at a frequency below.

The overall selectivity of a 465-kilocycle amplifier with rejectors set at 10 kc/s above and below resonant frequency is shown in Fig. 3; it will be seen that the skirts to the curve which are responsible for adjacent-channel interference with the ordinary "High-Q" tuned are

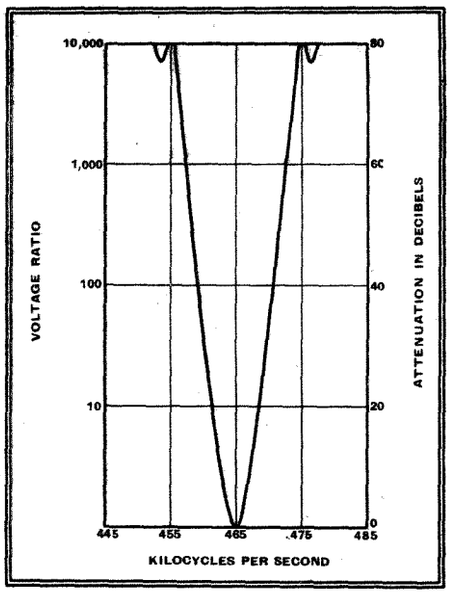


Fig. 3.—Response curve of IF stage with infinite rejection at + 10 and − 10 kc/s from resonance.

eliminated, and yet the curve is sufficiently broad for reasonably high quality reception

For "communication" types of receivers, where an even greater degree of selectivity is required, the use of four of these coupling units is suggested, two operating on either side of the resonant frequency. By making the capacity of one of the couplers variable it is possible to swing the rejection notch on either side of the carrier frequency, which proves of great value in removing heterodyne carriers.

Midget shielded condensers having a maximum capacity of 25 m-mfds. are suitable for coupling, and having once adjusted them to the required rejection frequency they should be left set. Where variable rejection is required these condensers should be shunted by a midget variable having a capacity of only one or two m-mfds.

News from the Clubs

Thames Valley Amateur Radio and Television Society

Headquarters: The Albany Hotel, Station Approach, Twickenham.
Meetings: Wednesday evenings at 8.15 p.m.
Hon. Sec.: Mr. L. Cooper, 3, Summer Avenue, East Molesey.

The next meeting is to be held on July 20th at 8.15 p.m., when the film of the Society's N.F.D. station will be shown.

Gloucester Radio Club

Hon. Sec.: Mr. G. G. E. Lewis, 30, Kitchener Avenue, Gloucester.

The above Society, founded early this year, is continuing its activities throughout the summer, and on July 3rd a 160-metre field day was held in the Stroud area. Another field day is to be held in August.

Bolton and District Chapter of the Radio Signal Survey League

Hon. Sec.: Mr. N. Moorcroft, 218, Deane Road, Bolton.

The Chapter now comprises seven members, five of whom have transmitting licences. Meetings are held on alternate Tuesday evenings at members' private addresses. The Secretary will be pleased to hear from local amateurs who are interested.

RANDOM RADIATIONS

By "DIALLIST"

What's An All Mains Set?

A RATHER interesting legal decision about a wireless term was given the other day, though I don't know that most of us, had it fallen to our lot to be on the Bench, would have come to quite the same conclusion as did the judge. Briefly, a man bought from a radio shop a bargain radiogram which was described as being an all mains instrument. He paid cash down for it and the radiogram was delivered. When he came to examine it he found that it was an AC instrument and therefore not suitable for his mains, which were DC. He asked for his money back, contending that the description of the set as "all mains" implied that it would work from mains of any kind. As the shop-keeper from whom he had bought the radiogram didn't accept this view the purchaser brought an action against him to recover his money.

What Would You Have Said?

The expression "all mains" is another example of the silly terms that we have in wireless. It is a survival from the period when the set run direct from the mains was just beginning to replace the battery model operated from what was known as a high-tension battery eliminator. This is now usually called either an HT eliminator (another misnomer, for you can't eliminate HT from a radio set) or simply an eliminator—which is worse still! Sets of this kind, you see, depended on an accumulator for their filament heating and so they were only partly mains set. The all mains set, on the other hand, was one which required no batteries of any sort or kind. I think that is what most wireless folk would say the term "all mains" had always meant: A set operated from the mains, whether it is an AC or a DC, or an AC/DC model.

The Decision

The judge held that though a very difficult point was raised, the purchaser had genuinely believed that the set would work off either AC or DC mains and that he was therefore entitled to cancel the bargain and get his money back. It was a kind and wise decision in the circumstances but I hope that it doesn't mean that there will be further confusion in our wireless terms by the giving of an entirely new meaning to the expression "all mains." That description should have been dropped long ago; "mains," alone, is quite sufficient. And that other horror "all-electric" has no excuse at all for its continued existence. Is there any receiving set which isn't all-electric? "Universal," again, is a misleading term, for it might well lead purchasers to believe that a set would work off not only mains of either kind, but off supplies of any voltage. Surely AC/DC is good enough, for it means what it says and says what it means.

Not So Hot

ONCE again I am not frightfully impressed by the poster selected for the Radiolympia Exhibition, though I admit that I have only seen small-sized black and white reproductions of it so far. It consists of a huge eye, on which is super-imposed a kind of ghostly ear. I followed it that far—radio and television. But why should the eye be looking through the ear? As a matter of fact the first impression you get, or anyhow that I got, was that of an eye peering through a queer-shaped eyeglass and shedding an outsize in tears from its inner corner. I understand that in the coloured version the eye is orange on a black background (I suppose that a black-eye on an orange background would hardly have done!) and that the ear is white. Is there some deep symbolism in the orangeness of the eye and the whiteness of the ear? If so I confess that it escapes me for the moment. Or is the poster a kind of by-product of one of those queer schools of art whose votaries stick odd eyes and ears and triangles and bits of cigarette packets all over their canvases? No, that poster leaves me guessing—which is, perhaps, what it is intended to do.

More Press-Button Sets

ALL sorts of new press-button sets are making their appearance and I'm glad to see that R.G.D. are adopting the motor system in their models. I am sure that really good motor-operated press-button tuning is the best of all, partly because sets that contain it are pretty well bound to have automatic frequency control as well. Like Ekco, R.G.D. have also devised means of making the motor work the wave-change switch when necessary, which is a first-rate point. Another good idea is the development of remote control for the press-button set. We have all become so thoroughly lazy nowadays that there is sure to be a warm welcome for anything that will enable a change to be made from one station to another by merely pressing a button and without leaving one's arm-chair! By the way, I must appologise to Ekco for having implied that they claimed that their "Radio Brain" would button-tune short-wave stations. They don't and they weren't responsible for the statement that misled me.

Off the Beaten Track

SOME queer problems come my way! Here's one that has just been set me by a correspondent living in Burma who is engaged in forestry. He wants particularly to be able to hear the Empire and other short-wave programmes, and with that end in view has acquired a British-made set, which I know to be a good performer. The big difficulty is filament current supply. Even at his headquarters there is no means of charging accumulators. He thinks that the air cell might do what is required there, but it is only for about five months in the year that he is at headquarters. During the other seven he is on tour, elephants being the only means of transport. He says that air cells would hardly be suitable, as the liquid electrolyte would certainly be spilt by the swaying of the elephants' gait. One way out of that difficulty might be to pour off the electrolyte into bottles fitted with secure corks and to carry the batteries dry. I don't *think* that that would injure the cells, though I can't say for certain until I've heard from the makers.

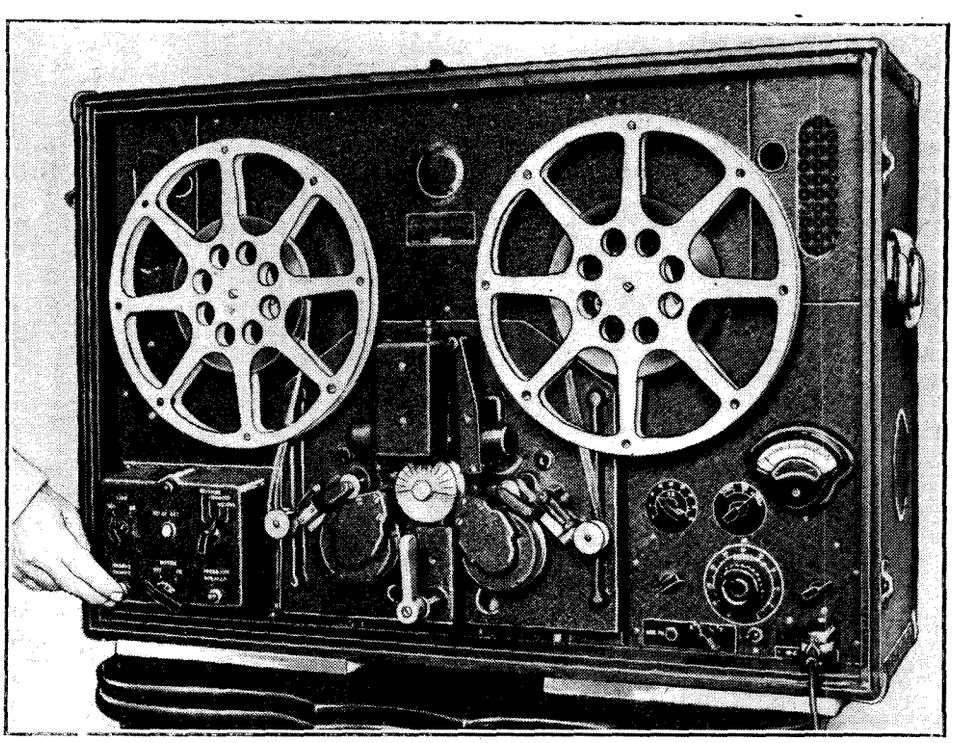


Photo. Courtesy of "Radio-Craft"

THIS SOUND RECORDING AND REPRODUCING INSTRUMENT, invented by J. Ripley Kiel in America, will record on 16mm. film stock 40 sound tracks side by side and permit instantaneous playback. As each track is filled the stylus shifts automatically to the next adjacent space. One 2,000ft. reel of the special unperforated, i.e., no sprocket holes, cellulose acetate film base will give 37 hours' continuous reproduction, or any part thereof. The cutting-head is an electro-mechanical device using a diamond-pointed stylus, with another diamond-pointed stylus for reproduction. It is claimed that even after 1,000 playings the tracks show neither wear nor deterioration in sound-quality.

Not Too Easy

There are also dry air-depolariser cells, which would seem to be almost ideal for the job in hand if they will stand up to the rather trying climate of some parts of the country. But there is still another part of the problem to be solved, and this provides the knottiest point. The receiving set is fitted with two-volt valves; therefore, two cells will be required, whether they be dry or wet. The open circuit EMF of the cells is about 1.5 volts apiece, though it is characteristic of the air depolariser cell that this rapidly drops to a little over 1 volt and stays there under the kind of load that the set would impose. Some means is needed for getting rid of the one superfluous volt or so that two cells in series would deliver for about the first twenty minutes after switching on. If all the valves took the same current, a single rheostat would suffice, but, unfortunately, they don't. Some pass 0.1 ampere, some 0.15 ampere, and one passes 0.25 ampere. So far as I can see, the only solution is to rewire the filament circuits so that they are arranged in three groups, each controlled by its own rheostat. As there probably won't be room for the rheostats in the set, they may have to be placed in a kind of distributor box.

Makers of battery sets intended for export purposes should, I feel, bear in mind the fact that filament current may have to be supplied by something other than accumulators. Some of them no doubt do so and provide their sets with means of cutting down the excess voltage of the supply. But others don't, and it may be a matter of considerable difficulty for users to adapt their sets for working off the dry or wet Le Clanché batteries that are most commonly used for filament-heating purposes where accumulator charging is impossible.

Television Across the Pond

THEY seem to have decided in America that they are not going to start anything like a regular television service until two things happen. The first is that they can find the material and the money for transmissions running continuously during the greater part of regular broadcasting hours; the second, that there are distinct indications that television is going to pay its way at once. It seems to me that if they stick to these ideas they will be a very long time before they get their television service going. The cost of big daily programmes such as they apparently have in mind would be stupendous and it couldn't possibly be met unless they were relayed to many big cities. This can't, of course, be done over long distances without the co-axial cable link, and just what the expenditure needed on that would be is a staggering thought. I have an idea that we shall still hold our lead in the television field for some little time to come with our more modest but, on the whole, pretty satisfactory system.

Miniature Televisors

ONE hears rumours about the development at present of miniature television receivers by several manufacturers. I believe that they are founded on fact and that models will be on view at the Olympia Exhibition this year. The idea was first mooted some time ago in *The Wireless World* (wasn't "Cathode Ray" the author of it?), and it seemed to find a certain amount of favour amongst readers. Whether or not the instruments will bear the same relation to the full-sized televisor as the headphone set does to the loud speaker radio receiver will probably depend to a very great extent upon the price at which they can be produced. Small cathode-ray tubes can be made quite cheaply, but there's a good deal more than the cathode-ray tube in the television receiver. In a midget televisor it will obviously be most important to make no sacrifice of brilliancy, definition, contrast or steadiness to cheapness of production, or the tiny images will make little appeal to the eye of the viewer. I believe that there is a future for the small-screen television receiver, but I hope that there won't be anything like the attempt to cut down prices at all costs that we have seen in "sound" receiving sets. Television, still a struggling infant, could receive no worse blow than that which cheap, nasty and unreliable televisors would deal it.

Television Programmes

Vision 45 Mc/s. Sound 41.5 Mc/s.

THURSDAY, JULY 14th.

3, Tennis, O.B. from Roehampton Club. **3.20,** Gaumont-British News. **3.30,** 163rd edition of "Picture Page." **3.50,** Croquet, O.B. from Roehampton Club.

9, Cabaret Cartoons. **9.30,** British Movietonews. **9.40,** 164th edition of "Picture Page." **10.10,** News Bulletin.

FRIDAY, JULY 15th.

3, Golf, O.B. from Roehampton Club. **3.15,** "For No Rhyme or Reason." **3.45,** Trick Riding, O.B. from Roehampton Club.

9, "In a Train to Exeter," short play by Anthony Shaw. **9.20,** Gaumont-British News. **9.30,** "E. and O.E.," a farce by Eliot Crawshay-Williams. **9.45,** Cartoon Film. **9.55,** "The Man in a Bowler Hat," a play by A. A. Milne. **10.10,** News Bulletin.

SATURDAY, JULY 16th.

3, Tennis, O.B. from Roehampton Club. **3.20,** In Our Garden; C. H. Middleton. **3.30,** Gaumont-British News. **3.40,** Archery, O.B. from Roehampton Club.

9, Cricket Demonstration by Herbert Sutcliffe. **9.10,** British Movietonews. **9.20,** "Nine Till Six," comedy by Aimée and Philip Stuart, with all-women cast. **10.10,** News Bulletin.

SUNDAY, JULY 17th.

8.50, News Bulletin. **9.5,** Lea Seidl, songs. **9.15,** Cartoon Film. **9.20-10.30,** "The Rivals," by Richard Brinsley Sheridan.

MONDAY, JULY 18th.

3, Jack Jackson and his Band. **3.35,** Gaumont-British News. **3.45,** "Under the Red Sea," talk illustrated by under-water drawings.

9, New Satirical Revue, "And Now Another," by Herbert Farjeon, A. P. Herbert and James Laver. **9.40,** British Movietonews. **9.50,** "Under the Red Sea," talk illustrated by under-water drawings. **10.5,** "Punch and Judex," Mr. Potter's joyous, judicial joke. **10.15,** News Bulletin.

TUESDAY, JULY 19th.

3, "In a Train to Exeter," short play. **3.20,** British Movietonews. **3.30,** "E. and O.E.," a farce. **3.45,** Cartoon Film. **3.50,** "The Man in a Bowler Hat."

9, Friends from the Zoo. **9.15,** Cartoon Film. **9.20,** "Ann and Harold," by Louis Goodrich, Episode II: At a Dance. **9.40,** Gaumont-British News. **9.50,** Tennis Demonstration by W. E. Tilden. **10,** News Bulletin.

WEDNESDAY, JULY 20th.

3-4, "Nine Till Six," comedy by Aimée and Philip Stuart.

9, British Movietonews. **9.10,** "The Case of the Frightened Lady," by Edgar Wallace. **10.40,** News Bulletin.

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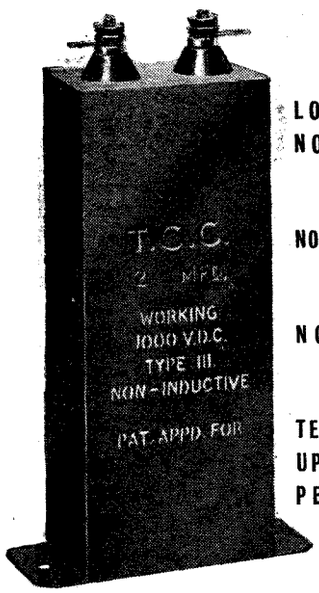
for the HIGHER VOLTAGES



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0.25	4 0	6 3	7 6	11 6
0.5	4 6	6 9	8 0	14 0
1	6 0	8 6	10 0	20 0
2	8 3	12 0	15 0	35 0
4	14 6	18 6	21 0	60 0
5	18 0	24 0	— —	— —
6	21 0	29 6	33 0	94 0
8	32 0	39 0	43 0	115 0
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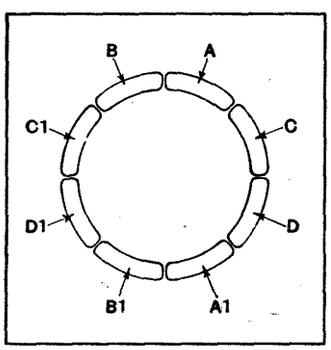
Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

SCANNING COILS

THE Figure shows a compact and convenient way of arranging the external deflecting coils of a cathode-ray tube. Only the ends of the windings are shown, the wires extending downwards, through the plane of the paper, parallel to the length of the tube.

The windings are arranged in quadrants, A and A1 representing the go-and-return wires of one winding, B and B1 the equivalent wires of another winding, and so on. The two windings A and B, acting together, deflect the electron stream at the rapid line-scanning frequency, whilst the



Method of arranging deflecting coils on stem of CR tube.

windings C and D similarly combine to deflect it at the lower or "framing" frequency. By suitably distributing the turns in each winding, the effect known as "pincushion distortion" is readily corrected.

A. D. Blumlein. Application date, October 20th, 1936. No. 483650.

o o o o

SCREEN-GRID VALVES

IN multi-grid valves one grid may be wound with a small pitch and another with a large pitch, whilst in the variable-mu type the pitch may be variable. The result is that a considerable proportion of electrons instead of passing direct to the anode are intercepted on their way, and produce grid current, particularly when the grid carries a positive potential.

It has already been proposed to arrange the windings of the different grids in such a way that they strictly lie behind each other in a straight line, as viewed from the cathode outwards towards the anode. This plan is, however, not always easy to carry into effect, particularly in the type of valve where the control grid (that is, the one nearest the grid) is wound with a close pitch.

According to the invention, an auxiliary grid is interposed between the control and screen grids, and is maintained at cathode potential. This produces a field distribution in the neighbourhood of the screen grid, which, no matter how closely the control grid is wound, prevents the electrons from striking the screen grid. In this way screen-grid current, and the resulting "rustling" noises, are avoided. Any grid or grids mounted beyond the screen grid should, of course, be arranged with their windings in line with the latter.

N. V. Philips Gloeilampenfabrieken. Convention date (Holland), June 22nd, 1936. No. 482992.

o o o o

TWO-WAY TELEVISION

A TELEVISION transmitter and receiver are arranged at both ends of a single transmission line, so that two persons at opposite ends can see each other simultaneously. Under these circumstances it is necessary for the transmitting tube to be inactive whilst the receiver is in operation, and vice versa. The "change-over" takes place at a speed of 30 times per second, so that the apparent continuity of the picture seen at both ends is maintained.

The intermittent break is effected, in both cases, by using the synchronising impulses of a sixty-frame-a-second picture, so that the transmitter and receiver become active and inactive, alternately, thirty times in each second. The circuits can, if desired, be switched-over so as to send a higher-grade picture, with sixty frames and interlaced scanning in one direction only.

Marconi's Wireless Telegraph Co., Ltd. (assignees of V. K. Zworykin). Convention date (U.S.A.), July 25th, 1936. No. 483622.

o o o o

LIGHT-VALVES

RELATES to a method of scanning in which a light-valve consisting of a tube of petrol, or other suitable liquid, is subjected to mechanical vibrations of supersonic frequency derived from a piezo-electric crystal. The incoming signals are applied to the crystal with the result that a beam of light, passed through the liquid, is modulated so as to reproduce the picture.

The carrier frequency usually coincides with the natural frequency of the crystal, but since the band of signal frequencies may extend over two megacycles, it is necessary to modify the input circuit to the crystal oscillator so as to give it, as far as possible a band-pass characteristic of the same width. This result is secured, according to the invention, by interposing between the signal-input valve and the crystal-operated light-valve, three tuned circuits which are tightly coupled together so as to give a "double-humped" resonance curve covering the required frequency band.

Scophony, Ltd.; J. Sieger; and J. H. Jeffree. Application date, October 2nd, 1936. No. 482665.

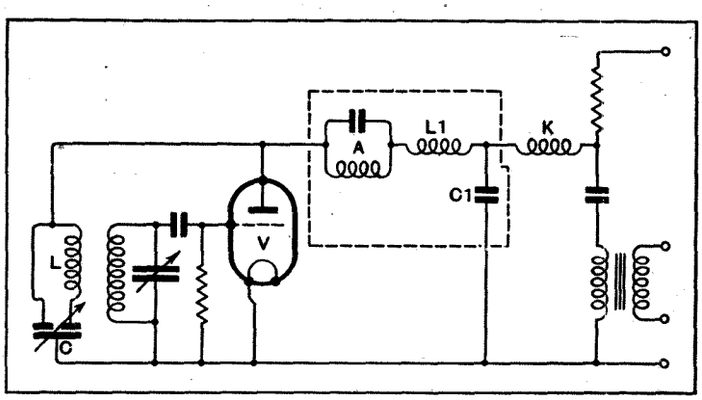
o o o o

A CONSTANT-REACTION SET

ONE of the problems in a wireless receiver is to devise a form of reaction which does not vary in amount with the wavelength to which the set is tuned. Various suggestions have been made to achieve this object, but they usually involve undesirable phase-changes, or otherwise make it difficult to "gang" or track the tuning of the circuit concerned with the other circuits of the set.

According to the invention an ordinary inductive back-coupling is "compensated" by means of a shunt circuit, which diverts energy away from the reaction coil to the extent required to offset the tendency for the reaction to become "fierce" on the short waves, and to fall off on the long waves.

As shown in the Figure a detector valve V is reactively back-coupled by a coil L and differential condenser C. The "compensating" circuit is enclosed by the dotted lines. It consists of a parallel-tuned circuit A and a series tuned circuit L1, C1, the whole being shunted across the anode-cathode circuit of the valve. The complete circuit has two points of minimum impedance, with a "hump" of maximum impedance between them. In this way energy is shunted away from, or forced into, the back-coupling coil L as the tuning frequency is varied. A choke K isolates the compensating circuit from the subsequent stages of the set.



Circuit to give constant regeneration over a wide range of radio frequencies.

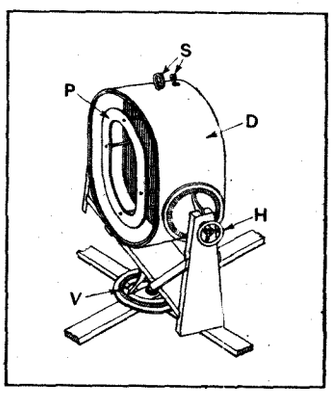
Murphy Radio, Ltd., and J. H. Balean. Application date, October 28th, 1936. No. 483504.

o o o o

SHORT-WAVE BEAMS

THE Figure shows a portable outfit for transmitting or receiving short-wave beam signals. A small dipole aerial is mounted inside a metal-lined reflecting drum D, which is fitted with a metal zone-plate P flush with its front or open face. This serves to screen the radiation from an equivalent zone on the back-plate of the reflector. The arrangement is said to produce a "linear," instead of the usual "point" focus, with a high degree of concentration.

The drum is rotated about a vertical axis by a hand-wheel V, and about a horizontal axis by a wheel H. Sights S facilitate



Direction aerial system for use on ultra-short waves.

accurate alignment of the reflector on to any distant station with which it is co-operating.

Standard Telephones and Cables, Ltd. (assignees of E. Bruce). Convention date (U.S.A.), September 11th, 1936. No. 483797.

o o o o

CATHODE-RAY TUBES

THE envelope of a cathode-ray tube is made of metal, i.e., of sheet copper, non-oxidisable steel, or other metals or alloys to which an end-screen of glass can be fused by an air-tight seal.

This gives a stronger structure, and simplifies the electrode assembly, since the outer wall also serves as an anode or focusing electrode. The other electrodes are fused into a glass "pinch," which is sealed into the lower end of the metal tube, and covered by an insulating base to carry the contact-pins and support the tube as a whole. The metal casing effectively screens the internal electrodes against outside fields of force.

A. Castellani and "Safar." Application date, October 28th, 1936. No. 483679.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

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28th Year of Publication

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Talk of Saturation

What Effect Will It Have ?

THERE has been a distinct falling off in the rate of increase in broadcast licences. This has led to more talk about saturation having been reached, and brings us face to face with the necessity for looking to the future supply of wireless sets to the public as mainly a replacement market.

The arrival of saturation must have a pronounced effect upon the trend of development of broadcast receivers, the attitude of the public buying them, and the problems of the salesman. There is a very great difference in the attitude of a buyer who says "I want to buy a wireless set" and one who says "I want to buy a *new* wireless set." Sales to those who have not previously owned a set have been comparatively easy, but the owner who contemplates buying a new set approaches the question very differently. He has had experience of wireless reception, his existing set probably still works well enough for the purchase of a new set not to be a matter of urgency, and he will want to know exactly what are the advantages to be obtained from the new model before he commits himself to a purchase. He will in all probability examine the claims of respective makers very carefully before he makes his final choice.

More Discrimination

This leads us to the logical conclusion that the successful manufacturers of the future will be those who produce sets with features of superiority and who do not merely manufacture, at a lower price, sets having a performance only equivalent to those already in the hands of the public. The manufacturer, too, will find it essential to talk intelligently, both in his literature and publicity matter, to prospective buyers who are already knowledgeable and experienced in the use of a set, and who will want to know far more about the next set they buy than they did in the case of their first purchase.

What is a Valve ?

Need for a Simple Definition

WILL some learned judge kindly oblige by asking the simple question "What is a valve ?" or better still, "What is a five-valve receiver ?"

In a County Court case reported recently the judge decided that the description "all-mains set" entitled the purchaser of an instrument so described to believe that it would work on any type of mains supply. This is an obviously sensible interpretation of the description but one which does not coincide with the meaning generally accepted by wireless people, who have for long described as an all-mains set any receiver which was independent of batteries.

In last week's issue an article discussed the position which has arisen as a result of the production of multi-valve types, rectifiers and other non-amplifying devices which are often included in the description of the number of valves in a receiver. It was shown that to-day it is hard to arrive at an idea of the performance of a set from a general description which states the number of valves without discrimination.

It may be that some naïve enquiry by a learned judge will provide in the same way the answer to enable us to distinguish between valves and valve stages and all those gadgets classified collectively as valves but which are in fact something else.

Synchronising in Television

WHEN THE AMPLITUDE FILTER CAN BE OMITTED

By CHRISTOPHER TIBBS
(Ultra Television Research Dept.)

IT is the usual practice to employ a special sync separation circuit to ensure that the sync pulses fed to the time-bases are unaffected by the vision signal. It is shown in this article, however, that when gas-triode saw-tooth oscillators are used a sync-separator is unnecessary if the proper precautions are taken.

THE designing of modern commercial television receivers might be called Economic Engineering, consisting as it does of a continual fight to reduce their cost. Upon examination of the cost of a television receiver one item stands out above all others, that of the valves, which may amount to as much as 25 per cent. of the total cost.

Most receivers on the market to-day use from one to three valves, serving no other useful purpose but that of separating the synchronising pulses from the picture intelligence and applying them to the time bases. If these valves, complete with all their associated components, could be removed lock, stock and barrel from the receiver and good synchronisation still be maintained, this would be a stride in the right direction.

The Ultra television receiver incorporates a unique circuit arrangement which supersedes the need for any separate valves or components to synchronise the receiver time-bases. In this circuit the gas-triode discharge valves in addition to generating the sweep voltages, separate the synchronising pulses from the picture intelligence. It is the purpose of this article to describe the circuit used and its action.

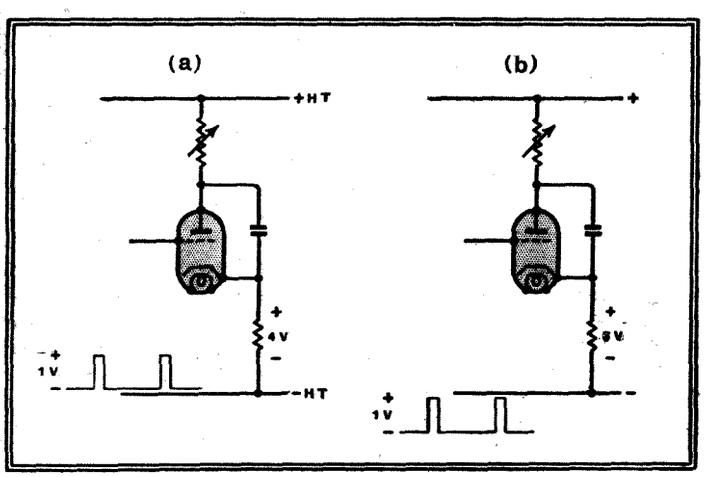


Fig. 1.—In (a) there is 4 volts standing bias derived from the cathode resistance and one volt positive synchronising pulse, but in (b) there is 3 volts bias derived from the cathode resistance and one volt extra bias which collapses during a synchronising pause. As far as the gas-triode is concerned the two conditions are the same.

We will first consider the normal method used to synchronise a gas-triode time-base. The gas-triode will have a standing bias of, say, 4 volts, which is usually derived from the voltage drop across a resistance inserted in its cathode circuit, as shown in Fig. 1. A synchronising pulse is manifest on its grid as a positive kick, which has an amplitude of the order of 1 volt. Considered in another way the grid bias on the valve is 4 volts during the transmission of picture intelligence and 3 volts during a synchronising pulse.

With the new method the gas-triode has the normal cathode resistance, across which the standing bias voltage is developed, but in this case the resistance is lower in value, only 3 volts being developed across it; Fig. 1 (b). The result of this is that at all times, other than that occupied by synchronising pulses, 1 volt extra negative bias must be maintained on the valve grid if the conditions are to simulate those of the normal synchronising circuit.

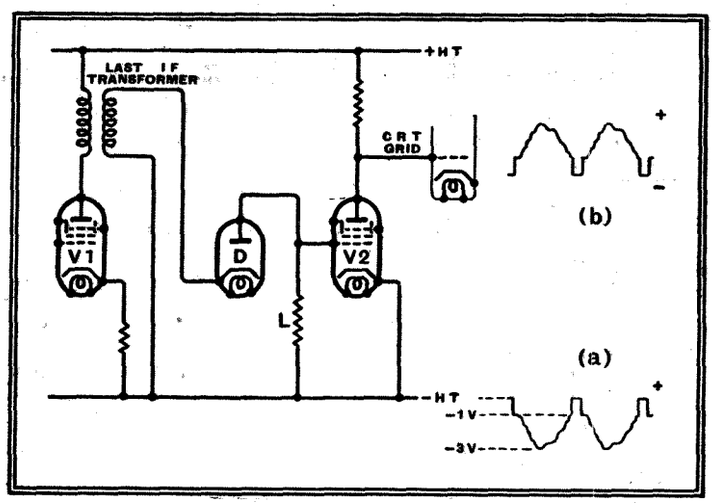


Fig. 2.—This diagram shows the vision output circuit used with the new system of synchronising. The waveform (a) is that across the diode load L and (b) is the waveform on the grid of the cathode-ray tube.

It will readily be seen that if a point can be found anywhere in the receiver which is at least 1 volt negative with respect to the −HT rail during picture intelligence and is at the same potential as the −HT rail during a synchronising pulse, the normal conditions will be simulated if the gas-triode control grids are connected to this point.

We are lucky in that we have not far to look in order to find such a point; it is the live end of the diode load. In order that the exact arrangement of this section of the circuit may be understood, we will look at Fig. 2 for a minute. The most important point to be noticed is that a VF amplifier is used after the diode detector. The importance of this valve is that, in addition to amplifying the vision signal, it inverts the signal waveform.

Operating Conditions

As a positive signal (i.e., white corresponding to a positive voltage excursion) is required on the control grid of the cathode-ray tube, the signal must be negative on the diode load (i.e., white corresponding to a negative voltage excursion) in order to compensate for the phase reversal of the VF valve. One end of the diode load is connected to the −HT rail, and therefore the other, the live end, must be negative with respect to −HT during the transmission of picture intelligence. If we assume that 3 volts are developed across the diode load for a peak white, then a black will be represented by 30 per cent. of this voltage, or approximately 1 volt. A synchronising pulse is transmitted as a complete cession of carrier, and therefore during both line and picture pulses there will be zero voltage

Synchronising in Television—

across the diode load. This results in the live end of the diode load being, at all times other than those occupied by synchronising pulses, from one to three volts below the –HT rail. The exact amount negative will depend upon the brilliance of that part of the image which is being transmitted.

Glancing back at the requirements of the gas-triode as regards synchronising, it will be found that they line up with the conditions existing on the live end of the diode load. Let us therefore connect its grid to this point, as shown in Fig. 3, and consider the voltage conditions existing between its grid and cathode. An initial bias of 3 volts is provided by the cathode resistance of the gas-triode. During a synchronising pulse this will be its only negative bias, whilst during the transmission of a black the total bias will be increased to 4 volts. The extra volt will be that generated across the diode load. As pointed out earlier, if the brilliance of the image is raised above that of a black, the voltage across the diode load increases. Taking, for instance, a white, we will have 3 volts developed across the diode load and another 3 volts due to the gas-triode cathode resistance, giving a total bias of 6 volts. The valve will remain in a cut-off condition so long as the bias does not drop below 4 volts, any increase in the bias merely tending to make doubly sure that it will remain in a cut-off condition.

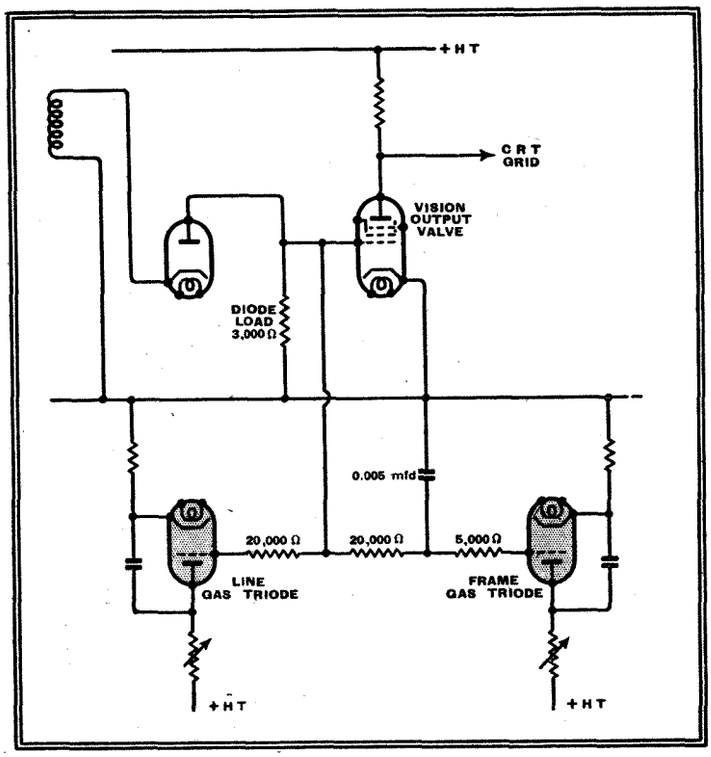


Fig. 3.—The complete synchronising circuit is given here together with the values of components.

A chart of the conditions existing in the gas-triode cathode-grid district is shown in Fig. 4. This chart makes the source of all the component sections of bias quite clear.

Having dealt with the theory of this method of synchronising we will pass on to the individual time-bases and deal with the practical difficulties encountered. It is most important, if the faults described later are to be avoided, that the line gas-triode grid-cathode capacity is kept to a minimum.

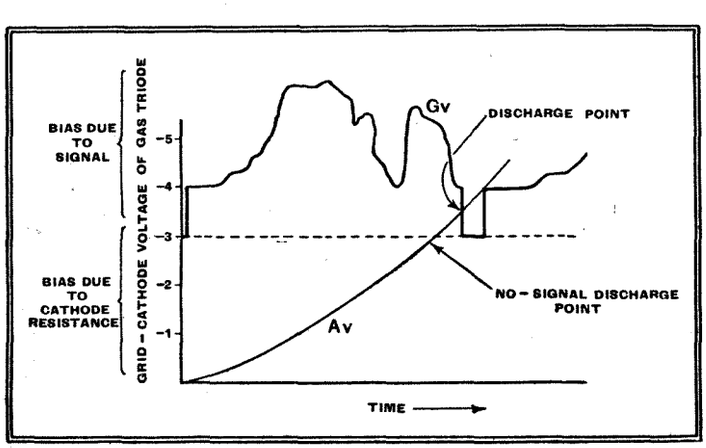


Fig. 4.—This chart shows the source of the component sections of bias. Gv is the actual voltage between the gas-triode grid and cathode, and the curve Av is the voltage to which the bias must drop at any time for a discharge to take place.

Due to causes which will be dealt with later it is necessary to insert a resistance of approximately 20,000 ohms between the grid and the diode load. This resistance and any capacity across the input of the gas-triode will form a circuit having a time constant which will temporarily maintain the bias on the grid after it has fallen to zero on the diode load. The first effect of this will be that the time-base will fire late, which will call for an excessively rapid fly-back for the spot to be at the beginning of the next line upon the commencement of the picture intelligence. The second, and by far the more objectionable, effect will be that of "pulling on blacks." If one line ends with white and the next with black, the grid input-capacity will take longer to discharge on the first line than on the second. This will result in the time base firing later on the first line than the second. These irregular time-base discharges, or the phase displacement of lines by picture intelligence, are commonly known as "pulling on blacks."

Interlacing

The point which requires most attention in synchronising the frame time-base is that of the interlacing. In the waveform transmitted from the Alexander Palace there are about six lines occupied by an unmodulated black frame which precedes every picture-synchronising pulse. Fig. 5 (a) shows the waveform before a picture-synchronising pulse.

It is necessary to connect a condenser across the frame gas-triode grid-cathode circuit in order to maintain the voltage across it during the line pauses, so ensuring that it will not be triggered by them. If the time constant formed by this condenser and the grid series resistance is less than six lines it is immaterial whether the preceding picture has been black or white. In each case the voltage on the grid will have settled down to the same value before the commencement of the frame-synchronising pause. As the voltage on the frame gas-triode grid is substantially the same before every picture pause, and always collapses at the same rate upon the commencement of a pause, it follows that the discharge will take place at a given time after the commencement of each picture pause. As the transmitted picture pauses are displaced from each other by half a line, it follows that the picture discharges will take place at intervals also displaced from one another by half a line, resulting in a reliable interlace.

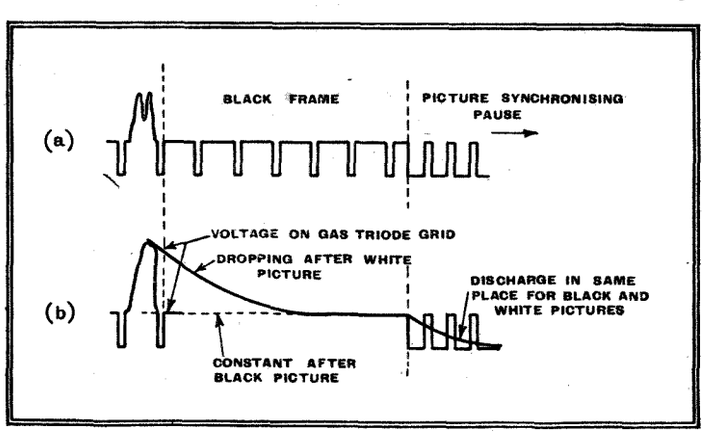


Fig. 5. — Provided that the grid time constant is shorter than the time occupied by the black frame, the picture discharge will be independent of the mean brilliance of the image, as indicated in this diagram.

Synchronising in Television—

Should the value of the grid condenser be made too large, the frame synchronising will be influenced by the mean brilliance of the transmitted image. The result of too small a grid condenser is insufficient attenuation of the line synchronising pulses and consequent destruction of the interlace.

Upon a discharge taking place through a gas-discharge triode the grid will be in an atmosphere of ionised gas, and will therefore tend to assume a voltage somewhere between that of the anode and the cathode. If, for example, there are 3 volts bias derived from a cathode resistance, the end of which is connected to −HT, then during a discharge the grid will be at least 3 volts positive with respect to the −HT rail. The practical result of this is a positive kick of some few volts (the amplitude will depend upon the value of the grid resistance employed) on the gas-triode grid every time a discharge takes place.

Let us assume for the minute that in order to synchronise the two time-bases we connected the line and frame gas-triode grids together on the live end of the diode load. As pointed out above, each grid, in addition to the signals received from the diode, would be contributing a pulse every time a line or frame discharge took place. The frame time-base would, under these conditions, be fired some few lines too early, due to the spurious signals generated by the line oscillator. In a similar way the line oscillator would have the bias on its grid reduced during a frame discharge, with the result that it will fire before it has received its correct synchronising pulse. The result in each case would be that the interlace is destroyed.

Gas-Triode Input Circuit

If, as shown in Fig. 3, a resistance is placed in series with the load to each gas-triode grid, the kicks generated there will have their amplitude appearing across the diode load reduced by the ratio of the series resistance to that of the diode load. In practice a ratio of 8 or 10 to 1 is found quite satisfactory and the faults described above are avoided. This arrangement results in each valve receiving the full voltage developed across the diode load, but at the same time contributing a minimum signal itself.

The resistance shown in Fig. 3 between the frame gas-triode grid and the 0.005 μF. condenser is to safeguard the valve from the excessive grid current which would otherwise flow as the result of the low AC grid return path formed by the condenser.

The synchronising system outlined above is extremely useful in conditions of severe interference. When correctly adjusted it is literally impossible to distinguish major objects in the image before a single line is tripped by the interference. The reason for this remarkably solid synchronising lies in the fact that it is necessary, in order to upset the time-base, to do one of two things. Either the carrier must be cancelled out long enough to trigger the gas-triode or the synchronising pause must be completely filled up with interference. The chances of either condition arising are very remote. The very simplicity of the system renders failure to synchronise in a correctly adjusted circuit virtually impossible.

In conclusion, it may be added that the system, which is the subject of a provisional patent, has proved eminently satisfactory in every one of the hundreds of television receivers to leave the Ultra factory.

In America Today

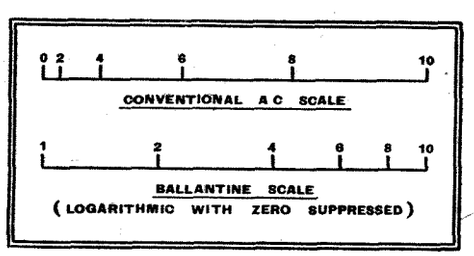
By Our Special Correspondent

THE BALLANTINE SENSITIVE AC VOLTMETER

At the annual convention of the Institute of Radio Engineers at New York City there was shown the new Model 300 Ballantine Sensitive Voltmeter, due to the Ballantine Laboratories of Boonton, N.J. This device consists of a DC meter preceded by a rectifier and a multi-stage high-quality amplifier having fine and coarse gain controls. The possibilities of such a combination have been utilised skilfully by the designer, Mr. Stuart Ballantine.

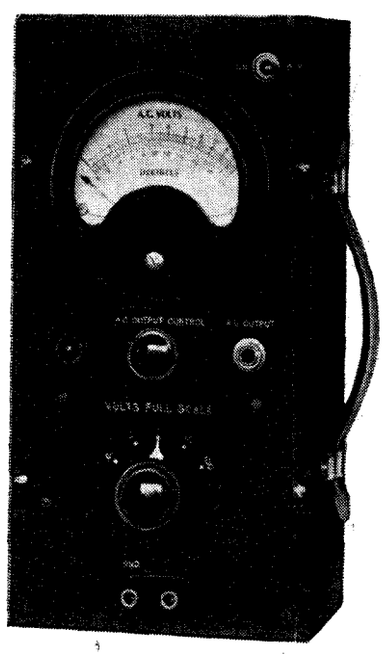
The meter and the circuit conditions are so chosen that the meter-scale is linear if considered in decibels; therefore, if calibrated in voltage the crowding takes place at the upper end, while the lower end is more open than that of a DC meter. The result is a very considerable increase in the ease of reading, a point better appreciated after a glance at the accompanying sketch of the Ballantine scale and that of a conventional AC meter. The zero does not appear on the Ballantine meter since a logarithmic scale has no zero point. When at rest the meter needle is somewhat to the left of the scale. A decibel scale is also provided as a matter of convenience. Its zero has arbitrarily been placed opposite 1 of the voltage scale, whereupon the 20-decibel mark necessarily lies opposite 10 on the voltage scale.

To secure proportionality between AC input to the amplifier and DC output from the rectifier to the meter it was essential



The scale of the Ballantine meter is shown here in comparison with an AC scale of ordinary type.

to cause the rectifier to act in a nearly ideal manner, which is to say its rectification characteristic must show a form approximating to two straight lines joined at an angle—not by a curve. Furthermore, it is necessary to make the entire system rather obtuse to changes in the amplifier tubes, due to either ageing or replacement. These two aims were accomplished by introducing amplifier feedback, which involves the rectifier. Fairly obviously, the effect of line-voltage changes is also reduced by such a circuit. A less obvious advantage is that the device is less influenced by harmonics than if the rectification were improved by resistance-ballasting. This is an advantage if one desires to measure the RMS value of the fundamental frequency, which is normally the case. The Ballantine meter is accordingly calibrated in terms of RMS values for a sinusoidal wave, but the user will



A view of the Ballantine meter as produced commercially.

do well to know what he is feeding into the meter, for its operating range extends from 10 c/s to 10,000 c/s, and readings are obtainable at much higher frequencies though with a larger error.

The voltage ranges are: 0.0001-0.01, 0.01-0.1, 0.1-1, 1-10 and 10-100, but the meter requires only a single voltage-scale which is multiplied by the factor opposite the pointer of the range-switch, just as in a DC instrument. The effect of the range-switch is to change the amplifier-gain; the maximum value is 70 db (3,100 times in voltage) with a variation of about 1 db from 10 to 10,000 cycles and with low harmonic distortion at outputs below 30 volts. The usefulness of such an amplifier for general laboratory work has induced the makers to provide an output jack. Insertion of a plug into this jack

disconnects the meter and rectifier, replacing them with a high-resistance output voltage-divider for fine control, coarse control being provided by the range-switch, which has steps of 10-1, as already mentioned.

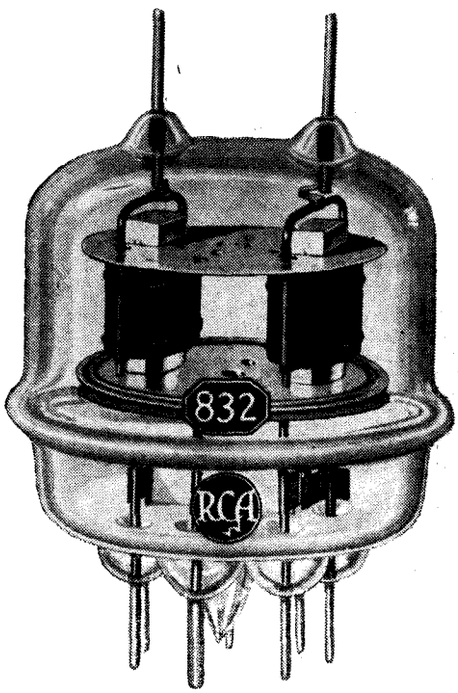
The utility of such a meter depends to a considerable extent upon minimisation of any loading effects upon the circuit under measurement. The input of the Model 300 "looks like" 500,000 ohms shunted by 25 micro-microfarads. This, and the wide voltage-range, make possible many direct measurements of output-over-input at any point in the audio range. These capabilities have been provided with a weight of somewhat less than 10 pounds and in a space of 4½in. by 6in. by 11in. The error is stated to be less than 2 per cent. over most of the range, at no point over 3 per cent., temperature effects negligible, and other causes of error (line voltage changes and tube changes) to be at or below 1 per cent.

ULTRA-HIGH FREQUENCY "DOORKNOB" TUBE

A FURTHER piece of apparatus described at the I.R.E. convention was another member of the growing family of UHF doorknob tubes. The earlier members of the tribe have been due to the Western Electric Company, and have been of both triode and pentode form, some with a single unit, others push-pull in the same bulb, and in a few instances the same element has been brought out at both ends of the bulb.

However, the latest variety, which is due to Radio Corporation of America, differs from all of these in that the twin pentodes are of the beam variety and especially because the screen-bypass condenser is at last placed inside the tube, where it has long belonged. These features permit the full amplifier-output of 22 watts (telegraphy) or 12 watts (telephone carrier) to be obtained at wavelengths as short as 2 metres, after which the output drops rather rapidly, falling off 50 per cent. at 1 metre, which is the shortest wavelength for which the tube is rated, though self-oscillation is possible somewhat beyond.

The plate voltage is 400 or 325 for telegraph and telephone outputs as above, and the screens may be supplied from the same source through a 7,500-ohm resistor which serves both screens. The grid bias of −60 volts (telegraphy) or −50 volts (telephony) may be obtained in the usual manner. In the foregoing it is assumed that plate-modulation is to be used. However, for UHF work it is sometimes convenient to employ grid-modulation and to accept a lower percentage of modulation, and a reduced carrier power. Here the RCA-832 gives an exceptionally good performance. With plate and screen voltages of 400 and 250 respectively there can be obtained a carrier power of somewhat more than 7 watts capable of acceptable 70 per cent. grid-bias modulation. In this case the screen voltage must be fixed, but bias may be taken from a 1,000-ohm cathode resistor.



The general arrangement of the RCA-832 is clearly shown in this photograph.

In all of the applications mentioned the driving requirements are modest, falling below 0.2 watt in all cases. In the demonstration before the Institute an 832 doorknob drove a 10-watt Mazda lamp well above normal brilliancy when its own grid was driven by a receiving "acorn" tube operating on quite low voltages. The output ceased when the acorn was switched off, showing that proper amplification was occurring.

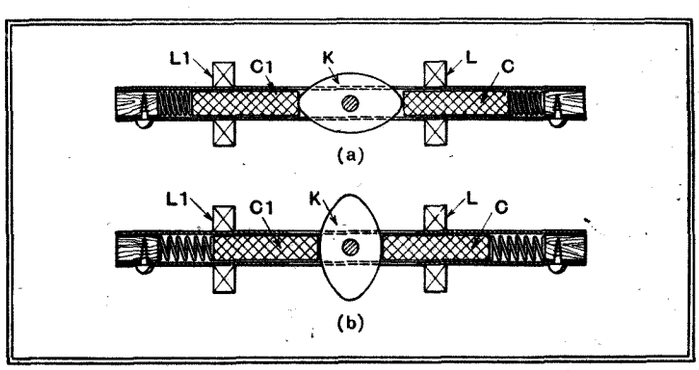
The glass doorknob body measures about 2in. each way, but the plate pins at one end and the other terminals at the opposite end raise the overall length to about 3½in. Incidentally, this terminal arrangement is very convenient when the tube is to be used with one pair of parallel rods connected to the plates and another pair to the grids, the plate supply and grid return being connected to the corresponding short-circuiting bridges of these rod-pairs. The driver may be coupled magnetically to the resulting grid loop and the load either coupled to the plate loop magnetically or tapped to the plate rods through stopping condensers in the conventional way.

The construction of the RCA-832 is best described by the accompanying photograph, which is due to the manufacturers, RCA Radiotron Division, RCA Manufacturing Co.

Variable Selectivity

SELECTIVITY can conveniently be adjusted to meet different conditions in the ether by varying the effective "width" either of the RF input or of the intermediate-frequency stages of a superhet. set. In both cases the band pass or filter effect of the circuits depends upon their tuning and mutual coupling.

The figure shows a neat arrangement (Patent No. 480755) for controlling the selectivity of a set by moving powdered-iron cores in and out of inductance coils. The coils L and L1 form part of a band-pass circuit, and are fixed in position on a supporting tube of insulating material.



Method of varying the coupling, and hence the band width of coupled coils, forming a band-pass RF or IF circuit.

Inside the tube slide two powdered-iron cores C, C1, which are spring-pressed from each end of the tube against an oval cam K mounted on the control shaft.

In the first position of the cam K the cores C and C1 are at their maximum distance apart, so that the coupling between the circuits is a minimum, and selectivity is high. It will be noticed that the cam K is not mounted midway between the two coils, but is placed somewhat nearer to L than to L1. At the same time, each of the cores extends well past both ends of the two coils, so that the self-inductance of both coils is approximately the same, and the tuning is not affected.

In the second position of the control cam K, shown in the lower drawing, the two iron cores have been brought close together, so that the coupling between the two circuits is tight, and selectivity is low. In this position it will be seen that the core C is symmetrical about the coil L, so that the self-inductance of the latter is a maximum. The core C1, on the other hand, is barely flush with one end of the coil L1, so that the self-inductance of this coil is near its minimum. This alteration in the self-inductance of the two coils varies the tuning of the two coupled circuits in opposite directions, and so helps to improve the quality of reception when the "control" is set for low selectivity.

Home Recording

By HUMFREY ANDREWES, B.Sc., A.M.I.E.E.

Part II.—The Recording Machine and Tracking Mechanism

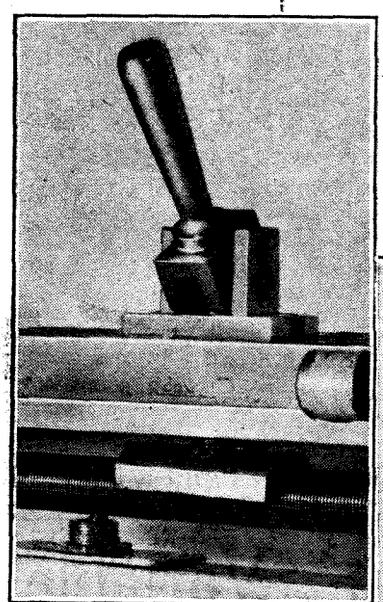
(Continued from page 26 of last week's issue)

IN this article the author deals with the recording machine and the mechanism that imparts the lateral movement to the cutting head. The various methods adopted are discussed, together with the points to which particular attention should be given in order to obtain a satisfactory spiral groove on the record.

IN the first article of this series consideration was given to the general theory of lateral recording and the size and shape of the groove cut in a directly recorded gramophone record. We next come to the recording machine by means of which this groove is cut. In the first place, the disc must be rotated at a perfectly uniform speed, and as a groove is being cut in the disc more power is required than when the finished record is replayed and the needle merely follows the groove. Secondly, the cutting stylus, which is mounted in the recording head, must be made to traverse the disc at a uniform speed in order that a spiral of the correct pitch may be produced.

At first sight this may all sound quite simple and, of course, in actual practice the mechanism required to perform the above functions is not really complicated. Unfortunately, however, small variations both in the speed of the recording table which rotates the disc and in the speed of the tracking mechanism, as it is called, which moves the recording head and stylus, are often very apparent to the human ear when the resulting record is replayed. It is usually the absence of such small variations that constitutes the difference between a good and a bad recording machine.

There is also one other important requirement in the recording machine mechanism. Owing to the fact that for obvious practical reasons neither the turntable of the recording machine nor the disc which is being cut can never be perfectly flat, the recording head must be mounted on the tracking mechanism in such a manner that the cutting stylus is free to move up and down so as to allow for the variations in flatness referred to.



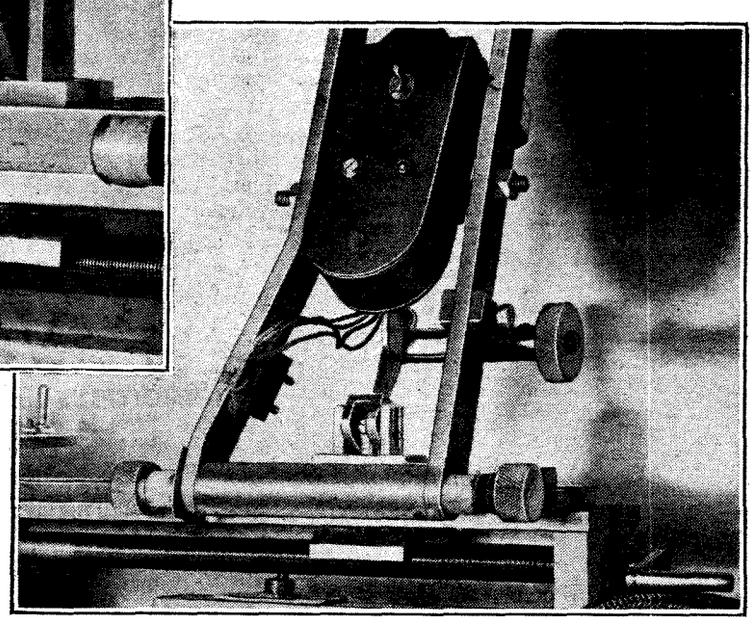


Fig. 2. — Two views of another type of tracking mechanism showing the method of disengaging the half-nut and recording head mounting.

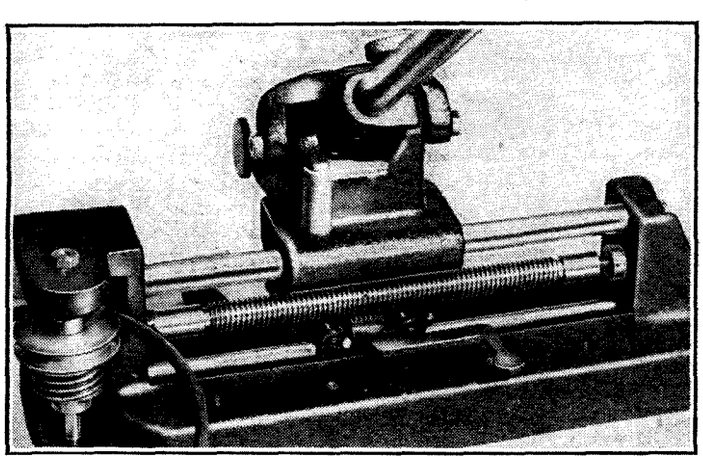


Fig. 1.—Tracking mechanism driven by belt from turntable spindle.

This movement is, of course, only small as the depth of the groove and the angle of the cutting stylus to the disc must not vary appreciably. This last requirement is very important as for satisfactory recording it is absolutely essential that the cutter head should be perfectly free to move in the vertical plane while being rigidly held in the horizontal plane by the tracking mechanism. This point will be referred to again in dealing with the subject of the recording blanks and their faults.

It is interesting to note, before coming to a consideration of the actual types of tracking mechanisms commonly used in direct recording machines, that whereas in such machines the tracking mechanism causes the recording head to move laterally across the recording table, in many of the wax recording machines used to-day the opposite action is used, that is to say, the recording head is fixed with regard to the base plate of the machine and the turntable moves laterally across it. Such an arrangement, while it has advantages, is perhaps more complicated and expensive to construct and is therefore not employed in the direct recording machines used by the amateur.

Tracking Mechanisms

An examination of the catalogues of the makers of the numerous machines at present on the market will show that there are several different ways in which the recording head may be made to traverse the turntable. Naturally, price plays an important part in the satisfactory operation of such apparatus, although some of the simpler and less expensive mechanisms can be made to function reasonably well if they are adjusted intelligently. It is not proposed here to review the various different machines available to the experimenter but rather to illustrate the various general types of tracking mechanisms and explain some of the faults which may

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arise and the methods to be adopted in dealing with them.

In practically all types of tracking mechanism the recording head is mounted on an arm, called the tracking arm, which moves on slides sideways in a similar manner to the slide-rest of a lathe. This arm is driven by a half-nut engaging with a rod on which is cut a screwthread. The half-nut is movable so that the mechanism may be engaged and disengaged at will at the beginning and the end of each recording.

Driving Systems

A view of such an arrangement is shown in Fig. 1. Another mechanism of a similar type is shown in Fig. 2. The tracking screw in this type of mechanism is driven from the recording turntable spindle usually by means of a leather or rubber belt. The pitch of the spiral groove cut in the record depends, of course, on the pitch of the tracking screwthread and the speed of rotation of the screw. In the more elaborate types the pitch of the recorded groove may be made variable by altering the speed of rotation of the tracking screw, either by a variable-speed gear driving the screw or by changing the size of the pulleys driving the mechanism. The belt which drives the mechanism is sometimes taken to a pulley on the centre clamp which holds the disc on the recording table, or alternatively to a pulley mounted on the turntable spindle and on the underside of the base plate. This latter method is more satisfactory as a general rule, as with the former it is necessary for the belt to be put on every time the disc is changed and the centre clamp removed, also there is a tendency for the swarf from the disc to get mixed up with the tracking belt and cause tracking faults.

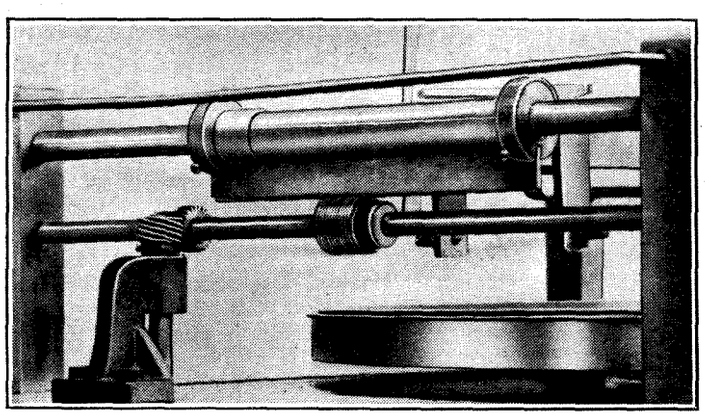

Fig. 3.—Tracking mechanism in which a worm driven by bevel gears drives a rack mounted on the tracking arm.

Another form of tracking drive is shown in Fig. 3. In this case instead of a tracking screw there is a worm wheel driving a toothed rack which is engaged and disengaged by raising and lowering the tracking arm. There are, of course, many other variations of this scheme and it is not proposed to give details of all the different mechanisms on the market, but rather to explain some of the faults which may occur.

It must be realised at the outset that the function of the tracking mechanism is to move the cutter head across the disc at a steady uniform speed, and any unevenness or variation in speed will be immediately apparent in the resulting spiral groove on the disc. It can cause variations in the pitch of the spiral and may even lead to one groove running into the next. To obtain good tracking, a tracking screw having a well-cut thread and of reasonably large diameter is required, and it should be free and run easily in its bearings. A leather belt is usually found better for the drive than a rubber one, as there is often a tendency for a "period" to be set up in a rubber belt giving a jerky drive to the tracking screw.

This last fault is often not obvious at first sight as tracking faults may appear in the recorded disc, although the tracking screw and half-nut may be perfect, but a close examination of the motion of the pulley driving the tracking screw while it is working will soon reveal the defect. Either a jointless belt should be used or care be taken with the joint to see it does not give rise to a variation in speed of one of the pulleys as it goes round. Metal fasteners should be avoided.

A periodic fault will occur in the pitch of the spiral corresponding to the speed of the pulley if the joint is too stiff or too big. If a small round leather belt is used, a good butt joint may be made by using catgut (the author has found that an old violin E string is excellent for this purpose). In most machines it is arranged so that a certain amount of slip can take place in the tracking mechanism drive so that no serious damage will be done to the tracking gears should the mechanism be allowed to overrun accidentally. In a more elaborate arrangement a small lever is arranged to operate a switch at the end of the travel of the tracking arm so that the motor is automatically switched off if the tracking arm overruns. Backlash in the half-nut or mounting of the tracking arm can play an important part in the satisfactory operation of any mechanism, and although it should be kept small it need not cause any trouble if care is taken to see that all the backlash is taken up before the cutter head is lowered when commencing a recording. All the above remarks may lead the reader to suppose that tracking faults are common and difficult to cure, but it should be emphasised that, provided a reasonably well-made but not necessarily expensive mechanism is used, quite good tracking may be obtained if the mechanism is looked after and kept clean and well oiled.

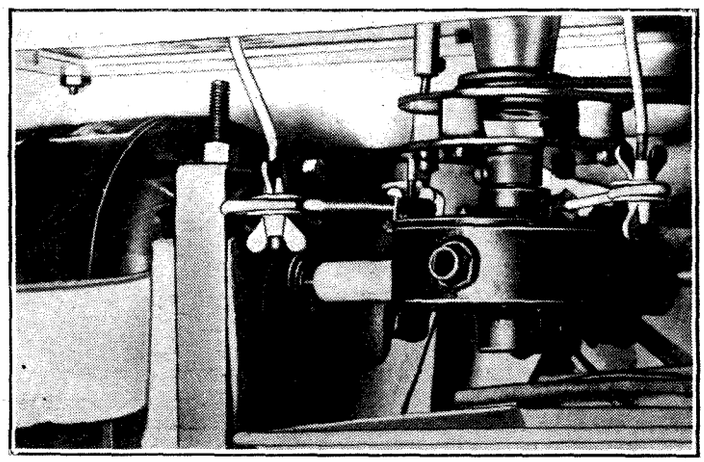

Fig. 4.—Underneath view of a recording machine in which the motor is coupled to the turntable spindle through a reduction gear box. Note the rubber motor coupling and mounting.

Before leaving the subject of tracking mechanisms it might be well to mention again the question of cutting from the inside to the outside of the disc instead of the reverse or normal procedure. The advantages of the former method have already been discussed in the first article of the series, and it is again suggested that for many experimental purposes, or when one is getting used to a new machine, the in-out cut avoids a number of difficulties, and it is, of course, only necessary to reverse the belt on one of the pulleys driving the racking mechanism in order to alter the direction of drive.

Motors

We come now to the consideration of methods of driving the recording turntable. This drive may be electrical, clockwork or by gravity, using a heavy-weight motor. The first is perhaps more usual in direct recording machines, although for small portable recorders the clockwork motor can be used very effectively. Where the space occupied by the recording gear is not important, the gravity motor, so often used in wax recording, has many advantages to recommend it; but, as recording engineers in the past have found, it is important to use a really strong cable to support the driving weight.

Where absolute constancy of speed is essential, either three-phase or single-phase synchronous motors are used, but for normal purposes this is rather an unnecessary elaboration. For alternating current

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supplies small induction motors are now available at very reasonable prices, and, for direct current, motors having very good constant-speed characteristics have been developed by a number of well-known firms. Low-voltage motors operated from a bank of car-starter type accumulators can also be obtained, and even with such motors a steady speed over a number of hours' run can be obtained with only small variations of the field resistance.

Power ratings vary considerably with different machines, and although some are rated as high as a quarter of a horse-power, one-eight horse-power is normally sufficient. This power is, however, more than can be obtained from the ordinary gramophone motor, and it is for this reason among others that the early home recorders were never entirely satisfactory. Special recording turntables have, however, now been introduced with the motor running at 78 revolutions per minute, but these cannot be classified with the ordinary gramophone motor. For details with regard to these the reader is referred to an article in *The Wireless World* for March 19th, 1937, and also the various catalogues issued by manufacturers.

Vibration

At whatever speed the motor runs, certain general principles are involved and certain precautions must be observed. For satisfactory operation of a recording machine all types of vibration, either on the recording turntable or tracking arm, must be avoided. A large number of different methods are adopted for mounting the motor, and it is usually essential to insulate the motor from the base plate on which the turntable is mounted either by means of springs or by rubber mountings. As a rule, most motors vibrate when they are running to a greater or less extent, and this vibration is transmitted to the turntable either direct, if the two are mounted on the same baseplate, or through the coupling between the motor and the turntable or reduction-gear box if a high-speed motor is used. This vibration, which must be eliminated by suitable mountings and resilient couplings, produces various different patterns on the disc, depending on the frequency of the vibration and the speed of the turntable. If the turntable speed is 78 r.p.m. and the motor vibration 50 cycles, a common case, the usual pattern is similar to a stroboscope disc, but in the form of radial lines like the spokes of a wheel.

Careful examination of a disc cut under such conditions shows that lines are produced by an alternate light and heavy cut due to a periodic vertical movement of the cutter head. This patterning of the disc is also sometimes called "watermark." One method of insulating the motor and gear box to avoid such vibration troubles is shown in Fig. 4. This is, of course, only one of many types, and in this case the speed of the motor (induction type 50-cycle) was 1,500 r.p.m. and the turntable speed 78 r.p.m. Fig. 5 illustrates one type of direct motor drive without reduction-gear box. Apart from motor vibration, pattern can be introduced by the gear box, either by tooth ripple or due to bad bearings, etc., but the motor is generally the cause of most of the trouble.

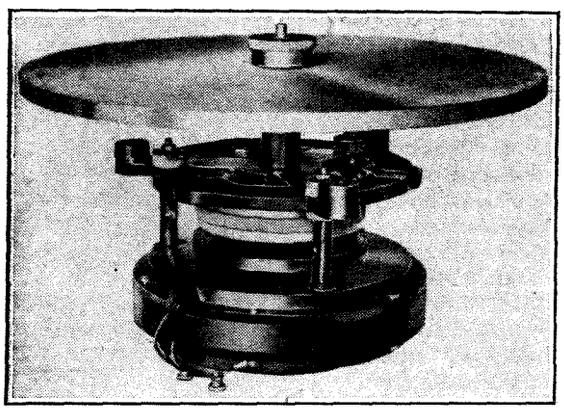

Fig. 5.—A direct coupled recording motor. A rubber washer insulates the turntable from the motor vibration.

One other very important point must be considered before leaving the subject of the motor drive, and that is "Wow." "Wow" may be defined as a regular periodic fluctuation in the speed of the turntable of either the recording or reproducing machine. It may be normally produced in two ways. First, by the fact that the hole in the centre of the disc is not, as a matter of fact, exactly in the centre, so that the distance of the replay needle from the spindle of the motor varies appreciably during one revolution of the disc. This type of "Wow" occurs mostly with shellac pressings, and gives the familiar 78 per minute variation with which the reader is probably familiar, and is, of course, not connected with the constancy of speed either of the reproducing motor or recording motor. It does not strictly come within the definition given above, as it is due to periodic variations of the speed of the point of the replay needle. Also, it does not worry the direct-recording experimenter as a rule, as, unless the centre hole of the disc becomes enlarged, no such variation in distance referred to above can occur. Variations in the speed of the recording turntable can, however, occur, and these are usually due to the misalignment of either the motor and turntable, in the case of the directly coupled machine, or of the motor and gear box, or of the gear box and turntable in the case of the other type of drive.

The complete removal of any periodic variation of speed is practically impossible, but with a little practice it is fairly easy to determine the amount which can be allowed in practice before it is noticeable in recorded music. Naturally, it should be the aim of the experimenter to get the amount of "Wow" in his recording machine down to the absolute minimum, but it is a curious fact that certain musical instruments when recorded on a gramophone record or, for that matter, on film, show up any variations in turntable speed far more than others. Any piece of music containing a series of long-sustained chords will serve as an excellent test of the steadiness of the recording turntable, but if these chords are played on a piano, as a general rule any variations will be much more noticeable. The piano tone seems to be particularly susceptible to "Wow." On the other hand, any instrument which is normally played with some "vibrato" is not so susceptible, except perhaps to the expert ear. In testing equipment for "Wow," using a constant-frequency disc, a frequency of about 500 cycles is generally used at 78 r.p.m. or 156 r.p.m., for "Wow" is most easily detected at about this frequency. Secondly, it is important to distinguish between genuine variation in frequency and periodic variations in intensity. If the record or the turntable is at all seriously out of truth, it is possible to get variations in the intensity of the 500-cycle note which have the same frequency as the variations in frequency of the note.

This sounds perhaps a little involved, but the two types of variation in the sound can be readily distinguished with a little practice provided that it is known that they both exist. Anyone who has had much experience with the adjustment of recording equipment and the removal of "Wow" will also know that it is only possible to carry out observations for a certain length of time, as the human ear tires when listening critically to one frequency, and after a time it is impossible to tell whether it is present or not unless the ear is given a rest. The subject is a most interesting one, and it is only possible to touch upon it in this series of articles. The frequency of the "Wow" may vary considerably with different recording machines and discs, and it may be of a frequency corresponding to one cycle per revolution of the recording table or take the form of a high-pitched flutter.

Turntable

We turn finally in our brief survey of the general action of the recording machine to the turntable itself. This should be massive in construction and reasonably heavy in weight, as it then acts as a flywheel and helps to smooth out both "Wow" and gear box and tooth ripples. On some machines the turntable alone weighs as much as 10 lb. to 15 lb. Some manufacturers dish the surface of the turntable—that is to say, turn it so that the centre of the turntable is an eighth of an inch or more thinner at the centre than at the edge. This is done so that when a metal-base disc is used the centre clamp pushes the centre of the disc down, and it is gripped on the edges as well as the centre, and slipping of the disc becomes practically impossible. This method also allows for variations in the flatness of the discs, and makes it possible for a reasonably good cut to be obtained on a disc which on a flat turntable might be too uneven or undulating on the surface.

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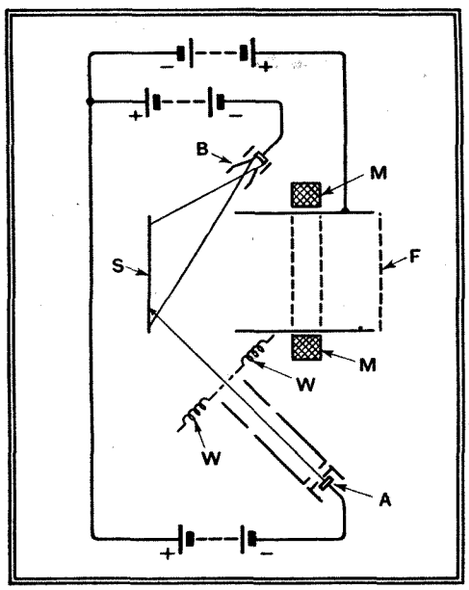
Before closing this particular portion of the subject, the author would like to point out that the details and illustrations given above are intended not to illustrate particular machines but particular principles, and that it is obviously impossible to illustrate and describe all the different ingenious mechanisms on the market at the present time, but only to describe and illustrate the principles on which they work.

Secondary-Emission Screens for Television

WHEN a sensitised surface is struck by primary electrons, the resulting secondary emission is determined partly by the material used for the screen, and partly by the velocity of the incident electrons. It appears, however, that a plate of nickel, when treated with uranyl nitrate (Patent No. 481563), is capable of emitting a more copious supply of secondary emissions after it has been subjected to a preliminary bombardment by electrons travelling at comparatively low speed.



Increasing the emission of secondary electrons from a treated nickel screen by a preliminary bombardment.

The Figure shows how this effect is utilised to increase the brilliance of a picture in television. The incoming signals are applied to modulate the electron stream from a cathode-ray "gun" A in the ordinary way, the stream being deflected by coils W so that it scans the specially prepared nickel screen S. This preliminary bombardment merely serves to prepare or modify the emissivity of the screen S from point to point in the manner mentioned above.

During the "flyback" interval, which follows the completion of each picture frame, the whole surface of the screen is simultaneously bombarded by a wide-sectioned beam which is projected at high velocity from a second gun or cathode B. This serves to release a copious supply of electrons from all points on the screen, so that it forms, in effect, an electron image of the original picture. The intensified stream is then focused by an external magnetic winding M on to a fluorescent screen F, at the other end of the tube, where the picture is viewed.

New American Valves

RANGE FOR DRY BATTERY OPERATION

FOR many years battery valves have been available with filaments rated for operation at 2 volts, this figure being chosen because it is the output of a single accumulator cell. There are many cases, however, where a dry battery is much more convenient than an accumulator. The output of such a battery is a variable quantity and depends upon its condition and the load upon it. In general, however, it is in the neighbourhood of 1.3—1.5 volts over a large portion of its useful life.

In a new series of valves recently introduced in America the filament rating is 1.4 volts and with one exception all specimens consume a current of 0.05 ampere. The valves are, in fact, designed for operation from a single dry cell without any filament circuit resistance.

The range includes a heptode frequency-changer 1A7G, which is rated for operation at 90 volts for anode and oscillator anode, and zero control-grid bias. The screen should be fed from 90 volts through a 70,000-ohm resistance. The currents for anode, screen, and oscillator anode are respectively 0.6, 0.65, and 1.1 mA. The anode AC resistance is 0.6 MΩ and the conversion conductance 0.125 mA/V.

The RF pentode is the 1N5G and is rated for 90 volts on the anode and screen and zero control-grid bias. Its anode current is 1.2 mA with a screen current of 0.3 mA, and it has a mutual conductance of 0.75 mA/V. It is a variable-mu valve of the short-base type.

There is a single-diode-triode in the range; this is the 1H5G. The anode rating is again 90 volts, and the valve has an AC resistance of 0.24 MΩ with an amplification factor of 65. It is, of course, intended for use with RC coupling. No grid bias is needed.

There are two output pentodes, the 1A5G and the 1C5G, the latter taking 0.1 ampere filament current instead of the usual 0.05 ampere. Automatic grid bias is recommended; the 1A5G needs −4.5 volts and the 1C5G −7 volts. Assuming a battery of 90 volts, the constants of the valves are consequently given for 85 volts and 83 volts anode and screen supply respectively.

The 1A5G consumes 3.5 mA and 0.7 mA anode and screen currents and has an output of 100 milliwatts at 10 per cent. distortion with a load of 25,000 ohms. The 1C5G, however, gives an output of 200 milliwatts for 10 per cent. distortion into a load of 9,000 ohms. It takes 7 mA anode current, however, with 1.6 mA for the screen.

The valves are fitted with the octal base and are of small dimensions, the overall diameter being only 1-3/16in. The longest valves are the top-grid types, which measure 4-5/16in. over all. In all types the length from the bottom of the base to the top of the bulb is 3-7/16in.

For details of these new Sylvania valves we are indebted to Messrs. Claude Lyons, Ltd., of 40, Buckingham Gate, London, S.W.1, from whom supplies may be obtained.

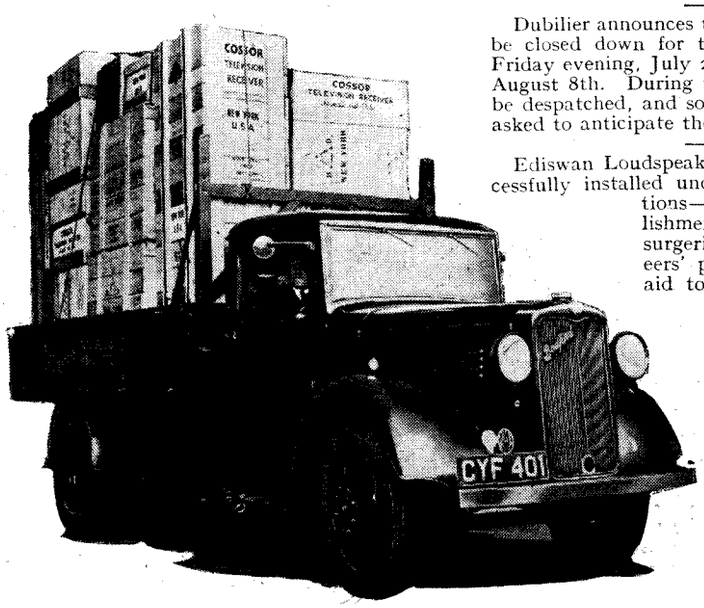
The Wireless Industry

Marconiphone will carry out the arrangement for sound amplification on the occasion of the unveiling by H.M. The King of the Australian War Memorial at Villers-Bretonneux. As electric supply mains will not be available, a large battery of Exide accumulators is being transported from England to feed the set of amplifiers, which incidentally have been specially constructed for the occasion. Marconiphone is also to be responsible for sound amplification during Navy Week at Devonport.

Exide batteries were used on Howard Hughes' record-breaking world flight.

Dubilier announces that the Acton works will be closed down for the annual holiday from Friday evening, July 29th to Monday morning, August 8th. During this period no goods will be despatched, and so the firm's customers are asked to anticipate their requirements.

Ediswan Loudspeakerphones have been successfully installed under many diverse conditions—in shops, catering establishments, on piers, in dentists' surgeries, hospitals, auctioneers' premises, and even as an aid to the detection of crime.



BRITISH TELEVISION SETS FOR U.S.A.—A consignment of Cossor television apparatus leaving the London works on the first stage of its journey to America.

UNBIASED

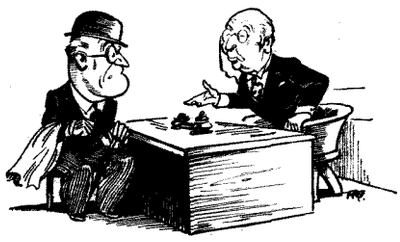
By FREE GRID

Medical Advice Wanted

I TRUST that you will forgive any slight falling-off you may have noticed in the past few weeks in the technical standard of these columns, but, as a matter of fact, I have not been able to give that care and attention to my scientific work which I like to do. This has been due, I am sorry to say, to certain domestic worries, and, although I hate bothering you with my personal affairs, I feel that I am compelled to do so to find out if any of you technical men have had any experience of the sort of thing that has been troubling me of late.

To come to the point, I have been worried in recent weeks about certain strange behaviour on the part of Mrs. Free Grid. Although I know it seems hardly credible, and some of the less charitable among you will, I fear, not believe me, she has started to take an avid and altogether unaccountable interest in wireless, and has bluntly announced her intention of applying for a transmitting licence. She spends most of the day surrounded by text-books, and has already rigged up the drawing-room as a very passable home-laboratory, following out the instructions now appearing on these matters in this journal.

Not only has she commenced to find fault with my own writings, but has been picking holes in the technical pronouncements of other writers in this journal, and has even extended her criticisms to the sacrosanct pages of *The Wireless Engineer*. I narrowly averted trouble only last week by short-circuiting a letter



Advice from Harley Street.

addressed by her to a person very eminent indeed in wireless engineering circles in which she flatly contradicted certain of his statements.

I am, in fact, only able to write these few words by reason of the fact that she is at the moment out of the country attending a technical congress in Berlin, whither I am arranging to send her a specially printed copy of this journal, with my article omitted.

Needless to say, I have taken the very best medical advice on the matter, and have consulted a well-known Harley Street psychologist, who tells me that she is suffering from an "obsessional neurosis resulting in an extravasation of her alter ego." He tells me that if there is to be any hope of a cure I must on no account thwart her in any way, and that she must be entirely "unrepressed." I ventured to point out to the medico that if this were the treatment it might be said with truth that she had been taking it more or less all our married life. His only reply to this, however, was a polite intimation that the three-guinea time limit was up.

I am, therefore, no better off than before consulting him, and am faced with a very grave problem indeed, as I expect that if the malady is allowed to go on she will probably be starting a wireless journal herself, or even setting up as a wireless manufacturer, and things would then become very difficult for me. If, therefore, any of you with specialised knowledge of these ills to which the human psyche is heir can help me, I shall be more than grateful.

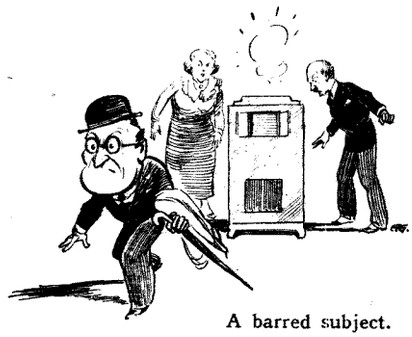
Teleolfaction

IT is, I think, astonishing how much non-scientific people take the wonders of this age for granted, and dismiss engineering feats of the greatest magnitude with a disdainful sniff. One of the most wonderful pieces of engineering, in my opinion, is the Forth Bridge, and only the other week when Mrs. Free Grid and I were crossing it in the train on a circuitous return from a visit to the Glasgow Exhibition I called her attention to it, and her only comment was that it was a pity that the engineers responsible had not sufficient common sense to make it wide enough to take a road as well as a railway track.

However, it is more in connection with wireless matters than with general engineering that this sort of thing has been brought home to me. Not so very long ago I was at a friend's house watching a television programme, the main feature of which was a cookery demonstration. The whole business was very well done indeed, so much so that I began to imagine that I could detect the smell of the cooking. My friend's wife, who was with us, merely gave a disdainful sniff and said that it was a pity that the B.B.C.'s demonstrator could not do better than that as he was obviously burning the dish.

I must confess that the picture was so vivid that even I got the impression that the dish was well done, but I was amazed when it turned out in the course of conversation that my friend's wife actually thought that the B.B.C. were transmitting smell along with the sound and vision. When I said this was not so, she bluntly demanded to know why, just as though the problem of transmitting smell by wireless was a minor one which could be left to some of the B.B.C. office boys to solve.

I am fairly well acquainted with modern psychology, and I immediately went into a long dissertation on the effects of hetero-suggestion, and explained that it was a high tribute to the B.B.C.'s technical skill that they could make the cookery scene so vivid that we had actually thought that we could detect the smell of cooking and even of burning. My friends were very interested in my little lecture, and more so since we were having such a striking demonstration of what I was talking about.



A barred subject.

We were, in fact, just about to telephone the B.B.C. and congratulate them on the remarkable vividness of their programme when the main fuse blew with a loud report, and on examining the back of the receiver we discovered a badly charred mains transformer. Psychology and hetero-suggestion is rather a barred subject with me at present.

Incidentally, I should like to say that I think it exceedingly bad policy for an all-electric concern like the B.B.C. to use a gas-stove for their television cooking demonstrations.

In 1938!

I THOUGHT that the hoary old "technical hint," which used to appear regularly in the "Wireless Corner" of certain journals, about using a jam-jar full of earth as a wireless "earth" was dead years ago. Apparently this is not so, as a reader has sent me a cutting from a woman's journal in which this advice (?) is once more given, together with an illustration and instructions to keep the soil moist. It is really very hard to believe that this sort of thing could be accepted for publication and good money paid for it in 1938, even in a woman's journal. It looks as though the gates of Eldorado were open to anybody who cared to send in a regular series of this sort of wireless hint; in fact, I am sorely tempted to do it myself. Before any of you commit yourselves to paper, do not forget that you must sign yourself Gladys, or something like that, and remember also to present your subject matter in a proper feminine manner; by this I mean do not attempt to do it in any scientific or even logical manner or you are liable to bring suspicion on yourself.

Neon Stabiliser

AN INEXPENSIVE "CONSTANT VOLTAGE" DEVICE

By D. H. THOMAS, M.Sc. Tech.

THE author shows how a single neon "night-light," plus a resistor, may be used to minimise voltage fluctuations in the HT supply to oscillators, etc.

THERE is one very useful application of the neon gas-discharge lamp which is not widely appreciated, and that is its use as a voltage stabiliser, or steadying device, on direct current. This article describes the fundamental application of an ordinary neon lamp, such as one used as a "night-light" as a device to keep the voltage on a piece of apparatus constant within close limits, independent of large fluctuations of the supply. Such a device is often useful for oscillators, or for calibrated amplifiers, where a constant anode or screen-grid voltage is necessary for constancy.

The curves of Fig. 1 show the current-voltage characteristic of an ordinary neon night-light. The one tested was a G.E.C. "Osglim" lamp, but is typical of them all. Curve A applies when the circular electrode is positive, and the spiral or "beehive" negative, and curve B when the connection is reversed. We will confine our attention to A, and it is seen that from about 6 to 24 mA of current a very small change in applied voltage brings about a very large change in current.

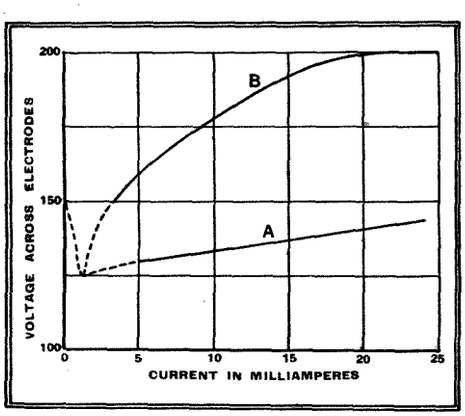


Fig. 1.—Characteristic curve of a G.E.C. "Osglim" neon lamp. Curve A, disc positive; curve B, spiral positive.

This region is of present interest to us, but we need not concern ourselves with the dotted part of curve A nor with curve B, as this polarity of electrodes is not important for our purposes.

Round about 16 mA on curve A, a voltage change of 10 volts produces a current change of 14 mA. We term the ratio of "voltage change/current change" the "differential resistance" of the device, designated by R*a*. Its value here is 10 ÷ 0.014 ohms, or 700 ohms. This differential resistance must be distinguished from the normal resistance of the lamp, for here 137 volts causes 16 mA to flow. The normal resistance R*n* is, therefore, 8,500 ohms.

Consider the action of this lamp in the circuit of Fig. 2. The mains, at voltage V_1, supply the load and the lamp through a ballast resistance R*b*. Suppose the voltage of the load R has to remain at a value of V_2, in accordance with Ohm's law, and the current it takes.

Let us suppose that matters are so arranged that V_2 lies in the region of the straight part of the lamp characteristic (or V_2 is round about 137 volts), and assume that V_1 increases. Due to the character of the lamp, a disproportionate increase of the current will be shunted off by the lamp. This will lead to increased volt drop in R*b*, this drop tending to neutralise the increase of V_1, and to leave V_2 as before. If V_1 drops in value, the lamp current decreases very rapidly. There is thus a tendency for the lamp to maintain a constant voltage at its terminals, any voltage change in the supply leading to large variations in the current taken by the lamp.

Practical Consideration

The size of the ballast resistance R*b* must be just sufficient to bring about a volt drop from the mains voltage V_1 to the voltage at which the lamp is to work. When the mains voltage is known it is an easy matter to calculate R*b*, knowing the current taken by the lamp, together with that needed in the load itself. In order to produce the maximum stabilising effect, R*b* should be as large as possible. This means that the current needed in the load should be small.

Another factor influencing the effectiveness of the device is the ratio of the two resistances rn and ra. For maximum stabilisation rn should be many times ra. In the lamp tested this was 21 to 1, and lamps specially designed for smoothing have this ratio much increased.

It will be seen that such a lamp can be used to stabilise voltages of the order of 140, and with suitable circuit conditions, the fluctuations in the mains are reduced to 1/5th by the time they reach the lamp. If smaller voltages than 140 are needed, a potentiometer arrangement or series dropping resistance can usually be applied. If higher stabilised voltages are needed it is always possible to use two lamps in series, with ballast resistance, across the supply which is to be smoothed.

Lamps intended for night-lights are provided with a resistance in the cap, this must be removed if the lamp is to be used as a stabiliser. It has been found convenient to cement the lamp into a valve socket, connecting the disc (which is to be positive) to the anode pin and the spiral to the cathode pin.

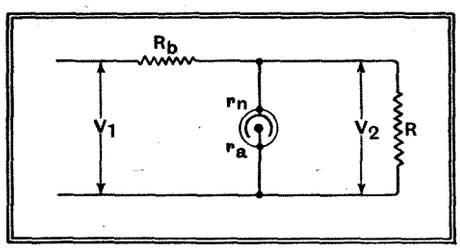


Fig. 2.—Circuit of the neon stabiliser.

In order to produce stability it is desirable to "age" the lamps by burning them, at their rated consumption, for about 8 hours on AC. If DC is used, reverse the connections during the "ageing" period, which normalises the gas conditions in the lamp.

As the lamp forms a shunt load the method is rather a wasteful one, but a few milliamperes wasted in the lamp is of no great moment if increased stability in testing gear is obtained. The use of a normal night-light, as here indicated, can produce a very useful amount of stabilisation.

This method of voltage stabilisation has been applied, with satisfactory results, to a radio-frequency oscillator using a circuit of the Collpitts type, which derives its high-tension supply from DC mains which are none too steady. The complete circuit, including stabiliser, is shown in Fig. 3

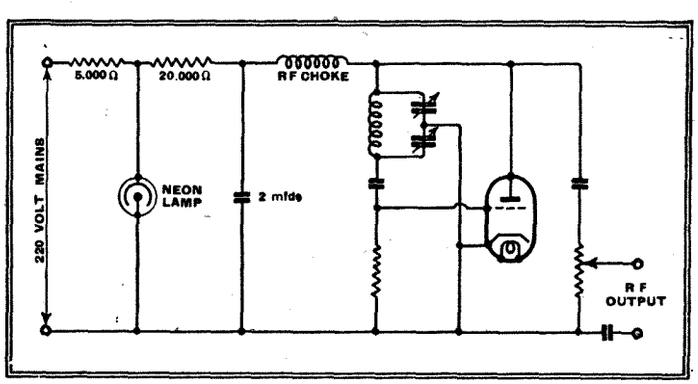


Fig. 3. — Illustrating the practical application of an "Osglim" neon lamp for stabilising the power supply of an RF oscillator.

Neon Stabiliser—

The HT input needed by the oscillator was 80 volts, and it took 3 mA. This supply voltage needed some reduction, as the stabilised voltage available, as explained above, is 135 volts. Hence the series resistance of 20,000 ohms in Fig. 3, and the 2 μF condenser. The ballast resistance needed is 5,000 ohms, as it drops 85 volts (being the difference between 135 volts and the mains voltage of 220), and passes a total of 17 mA for the lamp and oscillator together.

Calculations show that only 20 per cent. of the mains voltage fluctuations appear on the valve anode, and this contributes considerably to the stability of the oscillator.

APPENDIX.

Calculation of the degree of stabilisation.

If r_a is the differential resistance of the neon lamp, and r_n its DC resistance, and R_b and R are the resistances of the ballast and of the load respectively, it can be shown that the changes of the mains voltage V1 will appear as changes in the smoothed voltage V2 of :

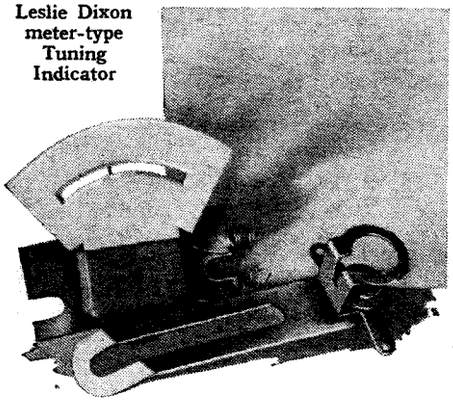
$$\frac{r_a}{r_n} \times \frac{Rr_n + R_b r_n + R_b R}{Rr_a + R_b r_a + R_b R} \times (\text{percentage change of V1})$$

From this it is at once apparent that for this ratio to be as small as possible, and for the smoothed voltage to experience only a small fraction of the changes in V1, we must have $r_n > r_a$ and also R_b and R as large as possible.

TUNING INDICATOR

A TUNING indicator of the milliammeter type is now marketed by Leslie Dixon and Co., of Electradix House, 218, Upper Thames Street, London, E.C.4. It is a moving-iron meter, and at rest the pointer is at the right-hand end of the scale. It must be included in the anode circuit of a valve controlled from the AVC system, and preferably one taking about 8 mA. The meter needle then moves to the left of the scale, and the decrease of current consequent upon tuning in a signal causes the needle to move to the right.

Leslie Dixon meter-type Tuning Indicator



The DC resistance is some 970 ohms, and the full-scale current is 8 mA. The meter is uncased but fitted with a plain card scale, and it is supplied with a sheet of mica to cover the panel opening and a bracket for a back-lamp. Complete it is priced at 3s. 9d. post free.

Television Programmes

An hour's special film transmission intended for the industry only will be given from 11 a.m. to 12 noon each week-day.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

THURSDAY, JULY 21st.

3, A Revue: "Life Goes On." **3.30,** British Movietonews. **3.40,** 165th edition of Picture Page. **9,** Repetition of 3 p.m. programme. **9.30,** Gaumont-British News. **9.40,** 166th edition of Picture Page. **10.10,** News Bulletin.

FRIDAY, JULY 22nd.

3, West-End Cabaret. **3.30,** Gaumont-British News. **3.40,** Cartoon Film. **3.45,** Catch-as-catch-can wrestling.

9, West-End Cabaret. **9.30,** British Movietonews. **9.40,** Speaking Personally: Vernon Bartlett. **9.50,** Cartoon Film. **9.55,** Music-makers. **10.5,** News Bulletin.

SATURDAY, JULY 23rd.

3, Cartoons by Ernest Mills. **3.10,** British Movietonews. **3.20,** A Revue: "And Now Another." **4,** Cartoon Film.

9, Three-Four: A Waltz Programme. **9.30,** Gaumont-British News. **9.40,** Starlight. **9.50,** Cartoon Film. **10,** Bridge Demonstration. **10.15,** News Bulletin.

SUNDAY, JULY 24th.

8.50, News Bulletin. **9.5,** Starlight. **9.10,** Cartoon Film. **9.15,** "The Danger of Tobacco," monologue by Anton Tchekov. **9.25,** Film. **9.40,** "The End of the Beginning," one-act comedy by Sean O'Casey.

MONDAY, JULY 25th.

3, Eric Wild and his Band. **3.20,** British Movietonews. **3.30,** Cartoon Film. **3.35,** "Order to View," a revue.

9, Cabaret. **9.35,** Gaumont-British News. **9.45,** Cricket Demonstration. **10,** Cartoon Film. **10.5,** Music-makers: Mildred Dilling (harp). **10.15,** News Bulletin.

TUESDAY, JULY 26th.

3, Forecast of Fashion. **3.15,** Gaumont-British News. **3.25,** Cabaret.

9, Forecast of Fashion. **9.15,** Cartoon Film. **9.20,** In Our Garden, C. H. Middleton. **9.30,** British Movietonews. **9.40,** "Ann and Harold": Episode 4. **10,** News Bulletin.

WEDNESDAY, JULY 27th.

3, A Little Show. **3.30,** British Movietonews. **3.40,** Cartoon Film. **3.45,** Repetition of Sunday's 9.40 p.m. programme.

9, Golf Demonstration. **9.15,** Gaumont-British News. **9.25,** "Nocturne in Palermo," by Clifford Bax. **10,** News Bulletin.

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, JULY 21st.

Nat., 7, Shows from the Seaside, from the Winter Garden, Eastbourne. 8, Revival of Bernard Shaw's "The Dark Lady of the Sonnets." 8.30, Helen Perkin (pianoforte) and the B.C.C. Orchestra (C).

Reg., 6, Continental romance, "Sweet Dreams." 7, Walks in London—III. 8, "Meet the Stars," from the New Hippodrome Theatre, Coventry. 8.45, Dialect Spelling Bee.

Abroad.

Hilversum I, 7.55, AVRO Symphony Orchestra, with members of the Italian Opera Company.

Paris PTT, 8.30, Charles Dickens' "David Copperfield," relayed from the Odéon.

FRIDAY, JULY 22nd.

Nat., 1.30, His Majesty unveils the Australian War Memorial at Villers-Bretonneux. 6.25, Test Match Commentary. 7.30, Radio Travel Bureau.

Reg., 6.45, The Colwyn Follies of 1938 from the Pier Pavilion, Colwyn Bay. 9, Reflections, a musical reminiscence.

Abroad.

Paris PTT, 8.30, Soulima Stravinsky (pianoforte) and the National Orchestra.

Brussels I, 9, Charpentier conducts excerpts from his opera, "Louise," at the Casino, Knocke.

SATURDAY, JULY 23rd.

Nat., 6.40, A Falla Concert—B.C.C. Orchestra (C). 7.30, "Foort-Issimo," Reginald Foort at the Theatre Organ. 8, Variety, including Rudy Starita and Wee Georgie Wood.

Reg., 6.40, Peter Yorke and his Orchestra. 8.35, Jan Stewer in his original part of George Growsell in his own Devonshire comedy, "Barnet's Folly." 9.40, The Return of Walford Hyden and his Café Colette Orchestra.

Abroad.

Strasbourg, 8.45, Wagner Opera Music from the Orangerie.

Rome I, 9, Wagner's "Lohengrin" from the Teatro delle Terme Caracalla.

SUNDAY, JULY 24th.

Nat., 11.15 a.m., The London Palladium Orchestra. 4, Pianoforte recital: Solomon. 6.30, Intermission—B.B.C. Variety Orchestra. 7.15, Recital: Peter Dawson. 9.5, Joint concert by the Band of the Garde Républicane and the B.B.C. Military Band.

Reg., 5, The Grand Hotel, Eastbourne, Orchestra, and Olive Groves. 9.5, "Semi-detached," radio comedy, adapted from P. G. Wodehouse's novel "Sam the Sudden."

Abroad.

Kalundborg, 4, Municipal Concert from the People's Park, Copenhagen.

Brussels II, 9, Concert from the Kursaal, Ostende, with Jo Vincent (soprano).

MONDAY, JULY 25th.

Nat., 6.25, Test Match Commentary. 7, The Bungalow Club. 8.10, "Press-Gang," the story of the British Navy of the 18th century. 8.50, Handel's opera "Perseus and Andromeda."

Reg., 4.15, Band of His Majesty's Royal Marines (Chatham). 7, Local Dishes with a West Country Flavour. 9.40, Fifth Speedway Test Match at Wimbledon. 10, George Gershwin: a commemorative programme.

Abroad.

Brussels I, 8.30, Concert from the Casino, Spa.

TUESDAY, JULY 26th.

Nat., 5, Royal Naval Singers. 6.25, Test Match Commentary. 7.30, "On Trek," programme devised by Josef Marais. 8.30, "Bournemouth Nights," fourth relay in series from seaside resorts.

Reg., 8.15, "Down on the Farm," a review of country life throughout the year. 9, "The Death of Phryne," one-act opera by L. Rocca, from the Turin studios.

Abroad.

Berlin (Funkstunde), 8.10, Bizet's "Carmen," with Helge Roswaenge in the cast.

Breslau, 8.30, Beethoven's Ninth Symphony, relayed from the Jahrhunderthalle.

WEDNESDAY, JULY 27th.

Nat., 7.20, Selections from "Rhythm Express." 8, "Dear Love," a musical comedy. 10.25, Meredith Willson, Music Director, N.B.C. Western Division, conducts the Variety Orchestra.

Reg., 8.15, "The Elephant," an anthology from the writings of the past 2,000 years. 9, Dance Cabaret from the Royal Bath Hotel Ballroom, Bournemouth.

Abroad.

Vienna, 8.10, Festival Concert relayed from Salzburg.

Bordeaux-Lafayette, 8.30, Jerome K. Jerome's play "The Passing of the Third-Floor Back."

Developing a High-Quality Communication Receiver

How a Receiver is Designed—XIX

THE RF AMPLIFIER AND FREQUENCY-CHANGER

WHAT may be termed the "fixed-tuned" parts of the equipment have been dealt with in the previous articles in this series. These include the AF amplifier and output stage, the detector and AVC system, the IF amplifier, and the variable-selectivity circuits. The method of tuning remains to be treated, and in this article the essentials of the RF stage and frequency-changer are discussed.

NOW that the essentials of the receiver circuits from the IF amplifier onwards have been dealt with, we must turn to the earlier stages. The IF amplifier operates at a fixed frequency and the signals we wish to receive are on many widely different frequencies; the amplifier, therefore, must be preceded by apparatus which will change the frequency of the wanted signal to that of the amplifier. This apparatus is called the frequency-changer. This name, however, is something of a misnomer, for, strictly speaking, the frequency-changer does not change the frequency of the incoming signal to the intermediate frequency. Instead, the incoming signal causes the frequency-changer to produce an output at intermediate frequency; the signal appears also in the output circuit at its original frequency.

The process of frequency-changing can be carried out in many different ways. One method is to use two valves, one as an anode-bend rectifier and the other as an oscillator. These are arranged as shown in Fig. 19, where LC is tuned to the incoming signal. The oscillator frequency is determined mainly by L1C1, the reaction coil being L3. A coupling coil L2 is provided in the cathode circuit of V1, whereby a voltage at oscillator frequency is injected into the grid-cathode circuit of V1. Between grid and cathode of this valve there is thus applied a total voltage which comprises the sum of the signal and oscillator voltages, the latter of which is normally considerably the greater.

As V1 is functioning as a rectifier, beats are produced in the anode circuit between the two input frequencies. If the signal input is fs and the oscillator frequency is fo, there will be currents in the anode circuit at frequencies fs and fo and also at fo − fs (or fs − fo, depending on which is the greater) and fo + fs. There will also be harmonics of all frequencies; *i.e.*, 2fs, 2fo, 2(fo − fs), 2(fo + fs), 3fs, 3fo, 3(fo − fs), 3(fo + fs), and so on. There are also likely to be more complex components, such as 2fo − fs, 3fo − fs, 3fo − 2fs, and so on.

Of all these currents at differing frequencies fo is the strongest, and in general fs is probably the next strongest. We are not interested in these, however, for we want to use the strongest of the beat frequencies; these are fo − fs (or fs − fo) and fo + fs. Normally we always use fo − fs, and the harmonic components of the anode current are very much weaker. In some circumstances these harmonic components can cause trouble, but they do not do so under normal conditions when the proper precautions are taken. It will be clear that to receive a given station of frequency fs the signal circuit LC must be tuned to the frequency, and it is then only necessary to adjust L1C1, so that the oscillator frequency fo is such that fo − fs = fi, the intermediate frequency. The selective circuits of the IF amplifier pick out this frequency to the exclusion of the other output frequencies of the frequency-changer. It should be noted that the oscillator circuit L1C1, must always be tuned to a frequency different from that of the signal circuit LC by the intermediate frequency; in practice, it is almost invariably tuned to the higher of the two possible frequencies.

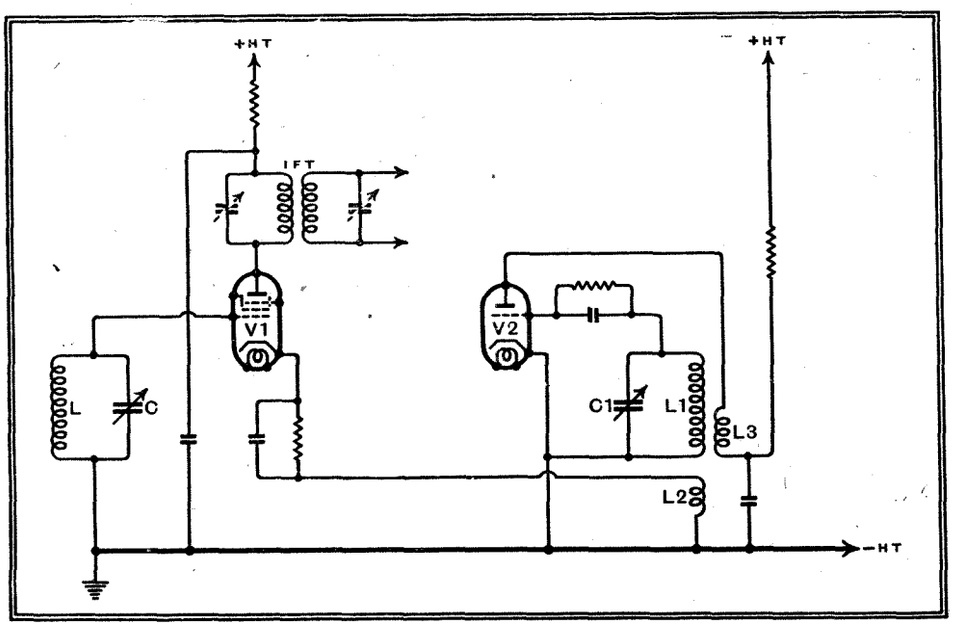


Fig. 19.—This diagram shows the now old-fashioned two-valve frequency-changer with cathode injection.

Electron Coupling

It is quite possible to use a single double-valve of the triode-pentode type in a slightly modified arrangement of Fig. 19, and entirely satisfactory results are obtained on the medium and long wavebands. On short waves, however, difficulties occur through the grid-cathode capacity of V1; this acts in conjunction with L2 to couple the signal and oscillator tuned circuits, with the result that the tuning of one affects the tuning of the other. This effect becomes increasingly great as the operating frequency rises, and is very serious on short waves.

The remedy is to adopt a form of electron coupling, just as we did in the case of the beat-frequency oscillator. The matter is complicated by the higher operating frequencies, however, and by the fairly large oscillator voltage needed on the mixing valve. Many special frequency-changing valves have appeared in the last few years, and it seems to be

High-Quality Communication Receiver—

generally agreed that the triode-hexode is the most satisfactory for short-wave work.

The circuit arrangement is shown in Fig. 20, and again LC and L1C1 are the signal and oscillator circuits respectively. The triode-hexode is really two valves in the same envelope. The triode section V2 is used as an oscillator, and the hexode section V1 functions as a mixing valve. The signal is applied to the innermost grid, and there are then two screen-grids, between which there is an injector grid which is connected internally to the triode grid. The full oscillator voltage is thus applied to the injector grid.

With this type of frequency-changer the formation of beats between the applied frequencies does not depend upon rectification. The beats are produced because the anode current which flows as a result of applying a signal voltage to to grid 1 depends upon the oscillator voltage applied to grid 3. The effect has been called multiplicative mixing.

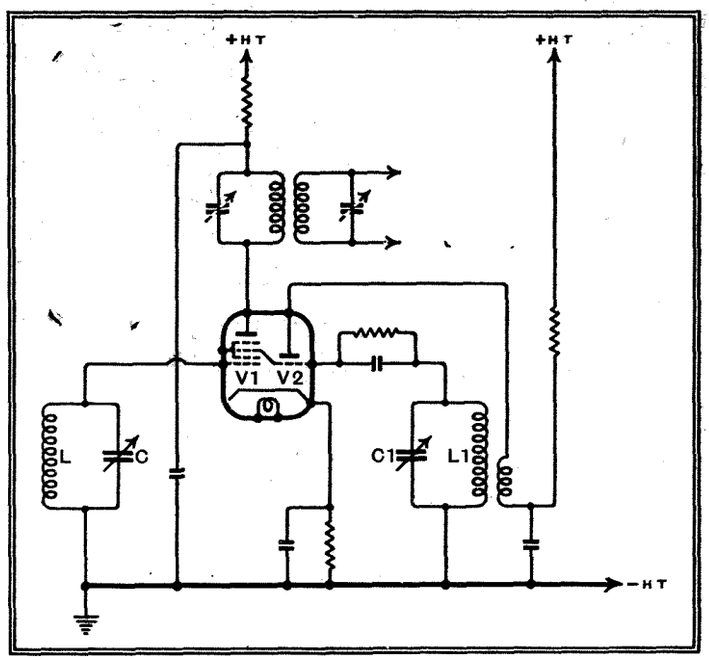


Fig. 20.—Modern frequency-changers are usually of the triode-hexode type, for the electronic mixing greatly reduces interaction between the tuned circuits.

Owing to the screening grids, inter-electrode capacities are low and the oscillator circuit is substantially isolated from the signal circuit. The isolation is not complete, for there is still some coupling left, but it seems to be better than with alternative arrangements.

The frequency-changer acts also as an amplifier, by which is meant that the IF output voltage on the IF transformer secondary is greater than the signal input voltage to the grid. The efficiency of the valve in this respect is expressed in terms of the conversion conductance, which is analogous to the mutual conductance of an ordinary valve. Instead of a valve of 1–3 mA/V, which is found for an RF pentode, the conversion conductance is of the order of 0.25–0.75 mA/V.

At first sight it would appear best to pick the valve with the highest value of conversion conductance, and if we were concerned only with the medium and long wavebands this might be the right course to adopt. On very short waves, however, there is another effect which comes into play. So far we have treated the input resistance of a valve as infinite. Apart from feed-back effects this does not lead to serious error at audio frequencies and moderate radio frequencies.

At very high radio frequencies, however, the time taken by an electron to pass through the valve is an appreciable fraction of the time occupied by one cycle of the input signal. This makes the valve absorb power from the input circuit, and the effect is most conveniently expressed as a fictitious resistance which, if connected between grid and cathode of a perfect valve, will have the same effect on the performance. In general, the input resistance increases with a decrease of conversion conductance (or mutual conductance in a triode, tetrode or pentode) and with a decrease of operating frequency. It also depends on the physical dimensions of the electrode system, increasing with a reduction in valve size.

A valve of high conversion conductance gives high gain, but its input resistance is low, so that the input circuit is heavily damped and only a small signal is actually applied to the valve. With a valve of low conversion conductance the gain is low, but the input resistance is high and the input circuit is much less heavily damped, with the result that a larger signal is applied to the valve.

Signal-Noise Ratio

The precise results depend upon the operating frequency and upon the efficiency of the signal circuit. In general, however, the frequency-changer of low conversion conductance gives a higher overall efficiency on short waves than the one of high conductance. Furthermore, as the tuned circuit is less heavily damped its selectivity is higher. This valve, then, is the better type in this case. In the Marconi and Osram range the valve is the X65.

Since we can easily obtain all the amplification we need at intermediate frequency there would seem little point in using a radio-frequency amplifier before the frequency-changer. This would be true if it were not for the noise introduced by valves. Any valve introduces a certain amount of noise, but provided that the stage gain is not below a certain figure it is only the noise of the first valve that has any appreciable effect. Now a frequency-changer invariably introduces more noise than a plain amplifier, usually about three or four times as much. Consequently, for minimum noise it is necessary to use an RF stage before the frequency-changer.

Valves are not the only cause of noise in a receiver, however, for the tuned circuits contribute some. When an RF amplifier is used it is usually possible to make the noise in the first tuned circuit the major factor in determining the signal-noise ratio. This is only on the medium and long wavebands, however, and on short waves circuit noise is usually negligible. It is, therefore, necessary to pick the first valve carefully for minimum noise.

Valve noise depends on the general design of the valve and upon the excellence or otherwise of its construction. The latter need hardly concern us nowadays, since it is only in defective specimens that constructional faults are likely to be a cause of noise. There are certain general valve characteristics which can help us in choosing a valve; in general, other things being equal, the valve with the lowest ratio of anode current to the square of mutual conductance will give the least noise. Other things are not always equal, however, and it is also found that the noise is proportional to the ratio of screen current to cathode current.

Problems in Radio Engineering. By E. T. A. Rapson. (Third edition.) Pp. 117. Published by Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, London, W.C.2. Price 3s. 6d.

THIS book consists primarily of a collection of examination questions representative of papers set by the City and Guilds, I.E.E., and London University; in the present (third) edition questions set as recently as 1937 are included. Answers are given at the end of the book, with occasional hints for solution, for those question which demand a numerical result; a feature especially useful to students working privately, provided, of course, that there are no errors in the answers given. A check of half a dozen of the questions appearing in this edition for the first time, and a comparison of the answers in this edition with those of the last having failed to reveal any discrepancies or amendments, we can feel some confidence in the accuracy of the answers as a whole. (But some of us may remember that once upon a time there was an official Government publication, the author or authors of which would have stood in great danger of being failed in any examination, since about 50 per cent. of the answers had to be "amended" in the next edition!)

Not the least valuable part of this book is the list of references and summary of formulæ and definitions set at the head of each group of examples; these might with advantage be expanded in future editions, even if such expansion rendered necessary the judicious weeding out of some of the earlier examples, and a section on AC bridges might perhaps be added. C. R. C.

NEWS OF THE WEEK

LISTENER RESEARCH: A Technical Questionnaire?

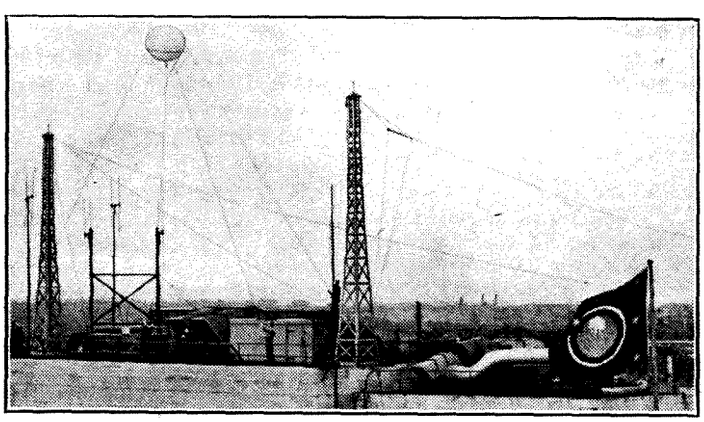
Intimate Knowledge of Reception Conditions

THE success of the Listener Research Campaign has been so great that the B.B.C. is understood to be considering an extension of the scope of these enquiries. Among the subjects to be enquired into may be that of radio reception generally, with particular reference to signal strength and quality of stations most favourably received.

The B.B.C. could with advantage obtain information from listeners on such points as the incidence of fading, the districts in which it is most noticeable, and the times of day when it is most in evidence. Interference might also provide a question on the enquiry form, though as this bugbear is properly the province of the Post Office, the Corporation would merely pass on the answers to the official quarter.

Much of the information gained would be of indirect value, but it would all supply the B.B.C. with that intimate knowledge of reception conditions and the problems of the listening public without which it is impossible to assess their real needs.

As evidence of the popularity of the questionnaires it may be mentioned that a few hours after the announcement was broadcast concerning the latest questionnaire, a fortnight ago, 5,600 applications for forms were received at Broadcasting House. Simultaneously the Post Office sent out the questionnaire to 4,700 families picked at random from telephone directories, and some 20 per cent. replied.



A CAPTIVE BALLOON riding gently over Broadcasting House was the subject of considerable speculation in London last week. Actually it was being used by B.B.C. engineers for reception tests of the transmissions from Daventry, as it permitted the use of various lengths of aerial.

ACTIVELY PURSUED!

Welcomed Words from the Post Office

THE Assistant Postmaster-General, Sir W. Womersley, in reply to a question in the House as to how many complaints approximately his department received annually of wireless interference by neon-sign installations and whether any action was contemplated in this connection, said that approximately 2,000 complaints were received each year. He went on to say that most of the owners of the offending signs agreed to fit suppressors, although there was no legal power to compel them to do so.

The closing words of his reply will be welcomed by all sufferers from man-made static, for he said: "The necessary enquiries regarding the possible scope and operation of a new Wireless Telegraphy Bill to deal, *inter alia*, with the question of electrical interference with wireless reception are being actively pursued."

Jerusalem Worries Manchester

THE B.B.C. is receiving a crop of complaints regarding the clashing of stations. Midland Regional listeners are complaining of high-pitched whistles, attributed to Bratislava, on 298.8 metres, and Mancunians are positive that North Regional is being heterodyned by Jerusalem, which is reported to be straying from the 449.1-metre wavelength which it shares with Slaithwaite.

COMFORTABLY ENSCONCED IN AN ARMCHAIR before the television-telephone apparatus in Munich which has just been linked with Berlin. In this official photograph the image on the cathode-ray tube shows much more than in actual practice when the head is larger and the image is cut off just below the collar. Note the loud-speaking telephone in front of the speaker.

TELEVISAPHONE

Latest Developments in German Television-Telephone

GERMANY has extended its television-telephone service which has for some time been in operation, linking Berlin with Leipzig and Nürnberg to Munich, which adds approximately 100 miles to the existing 300-mile link. It is, however, possible for only one person at a time to put through a call for although the four towns are now linked they are on one circuit. It is officially announced that Hamburg, Cologne, Frankfurt-on-Main, and probably Vienna, are to be brought into the system in the near future.

The extension was formally opened on Tuesday, July 12th, when German Press representatives were allowed free calls. On the following day the service was opened to the public, and the Berlin correspondent of *The Wireless World* was the first member of the public to use the new link. The cost of his three-minute call was Rm.4.80, plus 0.80 for the person called to be brought to the booth in Munich (about 9s. in all). He states that illumination was vastly superior to that when he used the Berlin-Nürnberg line. The person in Munich who, owing to the use of infra-red rays, appeared to be unshaven, was able to read the headlines of a newspaper held up in Berlin.

The use of a loud-speaking telephone has greatly improved the system. This employs a loud speaker of the moving-coil type which is used as microphone and loud speaker. A simple circuit arrangement renders the microphone dead whilst being used as a loud speaker.

Mechanical spot-light scanning is employed in the transmitter, which transmits 180 lines and 25 frames per second. Repeaters are used every 35 kilometres on the new extension, although for television broadcasting, when the German Post Office will use 441 lines and 50 frames interlaced, repeaters will be placed every 17.5 kilometres.

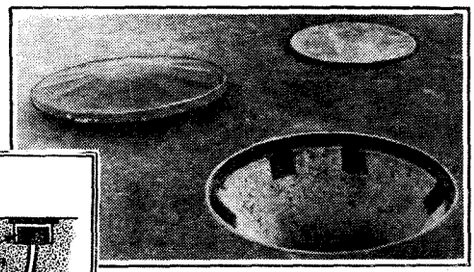
The picture frequency for the television-telephone is of the order of 500,000 c/s. This is imposed on a carrier of 1.3 Mc/s, the upper sideband being suppressed so that only the lower sideband is used.

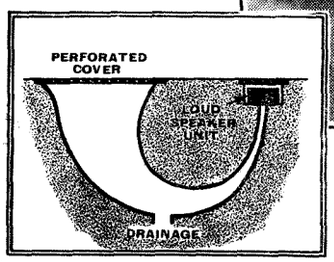
FORECASTING FADE-OUTS

Results of Listeners' Co-operation with Greenwich Observatory

AS a result of the co-operation of Empire listeners with the B.B.C. and Greenwich Observatory, it may in the future be

MR. A. J. GILL, B.Sc., M.I.E.E., M.Inst.-R.E., who is Chairman of the Wireless Section of the I.E.E., has been appointed Assistant Engineer-in-Chief of the G.P.O. Mr. Gill entered the Engineering Department of the G.P.O. as assistant engineer in 1913 and was attached to the Radio Section. He was appointed executive engineer in charge of the Radio Experimental Section at Dollis Hill in 1925, assistant staff engineer in 1929, and three years later staff engineer of the Radio Branch.





ACOUSTICAL PROBLEMS were successfully overcome, at the recent meeting of the Sokols (Falcons) in Prague by the use of twenty-four 25-watt ground loud speakers, one of which is illustrated above. As will be seen from the diagrammatic inset, the horn is built in the earth.

possible to warn listeners to Daventry of the approach of long-term fade-outs. Investigations show that complete fade-outs are preceded some thirty-six hours by a bright hydrogen eruption from an active sunspot crossing the sun's meridian. This delayed effect is apparently due to the emission of numerous charged particles from the vicinity of the sunspot. These travel at a much slower speed than light, and as they enter the ionised layers reduce the ionisation levels by contact with the electrons giving rise to poor conditions for propagation and the resultant failure of signals.

Many overseas listeners cable reports of fade-outs to the B.B.C., which information, together with the observations of B.B.C. engineers, is correlated with the accurate solar information supplied by the Greenwich Observatory.

TELEVISION AT OLYMPIA SHOW

Visitors to See Behind the Scenes

EXTENSIVE facilities for the public to see television programmes in production will be available at Radiolympia this year when, from August 24th to September 3rd, six hours of television programmes will be transmitted daily. The Radio Manufacturers' Association is erecting in the National Hall a large television studio with glass walls which will enable visitors to see artistes at work. The two principal programmes will be "Cabaret Cruise" and "Queue for Song"; Fashion Parades will be included daily.

For the first time two mobile television units will be in use during the Exhibition period. One will be installed at Olympia to relay the programmes to Alexandra Palace for retransmission, and the other will be operating first at the Kennington Oval for the final Test match, and, later, at the Zoo.

Each morning visitors to Radiolympia will be invited to face the television cameras so that their friends can see them on demonstration receivers which will be constantly working in different parts of the exhibition.

BOOK ON SCOTTISH BROADCASTING

ONE of the last occasions on which Sir John Reith put pen to paper as Director-General of the B.B.C. was to write a 140-word foreword to "Scotland on the Air," an exhilarating book compressing into 160 vigorous and vivid pages the history of Scottish broadcasting since that "Black Hole of Calcutta," 202, Bath Street, Glasgow, became the first Scottish broadcasting studio on March 6th, 1923. Compiled by George Burnett, the indefatigable B.B.C. Public Relations Officer for Scotland, this lively book will see the light towards the end of this month. Chapters on the first transmitter at Port Dundas power station, and photographs of this and the antiquated control room, should be of exceptional interest to *Wireless World* readers.

NEW I.W.T. REGULATIONS

AT a meeting of the Institute of Wireless Technology held on July 15th, the members unanimously approved the recommendations placed before them by the Council for revising the syllabus of examinations. The adoption of a new grade of membership, that of Graduateship, was also approved. In the opinion of the Council, the new grade will be appreciated by many who hitherto have not been eligible for admission to the Institute.

Copies of the Revised Syllabus and Membership Regulations, with appropriate application forms are now available and may be obtained from the Secretary at 4, Vernon Place, Southampton Row, London, W.C.1.

FROM ALL QUARTERS

"Tatsfield" for South Africa

THE South African Broadcasting Corporation is reported to have purchased a 96-acre site near Johannesburg on which to erect a powerful receiving station for relaying the world's short-wave stations to listeners throughout South Africa.

Hospital Wireless

THE position of the hospitals regarding the payment of wireless licences was clarified by the Assistant Postmaster - General when, in reply to a question in the House last week, he stated that a single wireless licence taken out by a hospital authority covered the installation of any number of receiving sets for use by patients in the hospital.

Inter-Communication in the Army

THE Royal Corps of Signals, which is responsible for inter-communication in the Army, will, from August 1st to 13th, display its equipment and demonstrate its skill in the Services Pavilion of the Empire Exhibition, Glasgow. Visitors will see W/T stations working, repairs in the workshop, and demonstrations of alternative methods of communication, namely, wireless, wire, visual, and despatch riding.

"Aircraft Production": A new Journal

OUR publishers, Iliffe and Sons Ltd., are shortly to issue a new journal, to be entitled *Aircraft Production*. The aim of the publication, which will appear monthly, is to promote efficiency in the aircraft industry by co-ordinating design and production and by disseminating modern ideas on the manufacture of airframes, engines, and accessories.

More Power for Sweden

ALTHOUGH it is less than two years since the 100-kW Hörby transmitter was put into service, the Swedish Administration of Posts and Telegraphs has given the contract to Telefunken for another 100-kW transmitter to be erected at Falun. This will replace the present 2-kW station, which works on 276.2 metres.

Calling All Cars!

POLICE loud speaker cars were put to a new use during Her Majesty Queen Mary's visit to the Tower of London last week. Owing to the limited space in the vicinity, the cars of those attending the garden party were parked a quarter of a mile away, and when wanted their numbers were announced by a police patrol car which was receiving wirelessed instructions from a transmitter at the Tower entrance.

Duplex Radio for Gliders

SUCCESSFUL experiments were recently conducted by the Yorkshire Gliding Club in duplex radio-telephone communication between a glider and a ground station.

Wired Wireless for A.R.P.

A FEATURE of the Wimbledon (London) A.R.P. scheme is the method of communication to be used if the telephone system is put out of action. The apparatus is plugged into the electricity supply, the cables of which then become the medium for carrying the transmissions to a receiver plugged into the same power supply. Even though the current were cut off, the apparatus is still usable, for it does not rely on the mains for power.

Empire Trophy Comes to Britain

THE 1938 British Empire Radio Union Reception Contest has been won by Mr. M. G. Bourke, of Jersey. At his SW station 2AOU, he was successful in receiving and working stations in twenty-two divisions of the Empire; his achievement brings back the trophy, which has been in Australia for the past two years.

New Osram Battery Valve

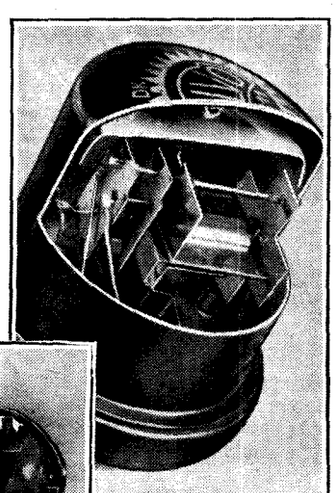
THE General Electric Company announces a new 2-volt double-diode-triode 5-pin battery valve with a top cap for the control grid. Considerable stage gain is obtainable by reason of its high amplification factor (40) whilst its low filament consumption (0.15 amp) provides economical operation. It will be known as Type HD23 and is priced at 9s.

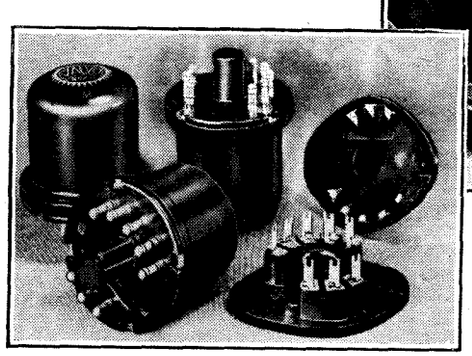
PA to the Rescue

IN Finland many of the large bathing beaches have been equipped with PA apparatus, which, as well as relaying music, are used at intervals throughout the day to give instruction on rescue work.

Is This a Record?

IT is understood that the broadcast of the Louis-Schmeling fight cost the Buick Motor Company, the sponsors, over $47,000 for the limited period of fifteen minutes. This sum was paid to the N.B.C. for the commentaries to be radiated over 146 stations.





NEW GERMAN METAL VALVES which have an entirely new style of base, and as can be seen from the cut-away photograph, have the electrodes mounted horizontally. The diminutive size of these Philips valves can be judged by comparison with the holders shown.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Educating the Public ?

I THINK "Diallist," in *The Wireless World* of June 23rd, rather missed the point of Mr. Eric Cundell's accusation that the B.B.C. has missed a golden opportunity of educating the people's taste for good music. The performance of good music does not in itself "educate" taste—education must come before appreciation. To give an analogy, the broadcasting of, say, Molière's works would not educate the public's taste in the French language if they had not previously learnt the grammar and vocabulary. A listener receives music in the form of a complex wave, and he cannot analyse it unless he has been trained to recognise the timbre of the various instruments. It is not sufficiently recognised that a symphony or a string quartet sounds to the untrained listener as a mere noise.

Formerly, the youngster went to concerts, saw the different instruments played, listened to his elders discuss the qualities and the form of the music, and so learnt how to listen. What chance has a youngster to learn to appreciate music when it comes to him in the form of crooning, jazz, or sugary tunes by somebody's sextet "drooling" away all the time as a background to the conversation, quarrels and other noises incidental to domestic life? His elders, so far from helping him, do not even listen, or occasionally say "How nice!" or "Turn it off and try somewhere else."

Those who understand music appreciate the B.B.C.'s work, but it is doubtful if anyone's taste is educated by it.

The B.B.C. might help by broadcasting items by individual orchestral instruments, then music combining a few instruments, such as Bach's Brandenburg Concertos, Mozart's Serenades, etc., then introduce the complete orchestra by way of the earlier symphonies, such as those of Haydn and Mozart. Analysis of the structure could be given in *The Radio Times* (instead of the present unhelpful notes). Television, when it becomes general, would be a great help.

London, W.4. H. W. LEE.

Debunking Harmonic Distortion

I HAVE just read with much interest the article entitled "Debunking Harmonic Distortion," written by "Cathode Ray," appearing in your May 19th, 1938, issue.

The condition which the author describes as "inter-modulation distortion" has been recognised in the United States for some time past. The first printed reference thereto which I at the moment recall was contained in an engineering bulletin issued early in 1936 by the Ken-Rad Corporation, of Owensboro, Kentucky.

While I cannot state absolutely definitely, I believe from my own engineering acquaintance and experience that attention was first focused upon what we in the United States term "modulation product distortion" some two years ago. At that time Class B amplifiers were still popular in radio receiver and public address amplifier design. A few enquiring souls sought to determine why a Class B amplifier, which under conventional measurement technique exhibited not over 5 per cent. total harmonic distortion, sounded so unutterably "sour" when employed for musical reproduction.

Someone—I don't know exactly who did it first—suspected the generation of sum and difference frequencies such as might be anticipated as arising in any circuits containing rectifying elements, and so measured a Class B amplifier using not one but two signal sources. Suspicion of the generation and presence of sum and difference frequencies as soon as two different frequencies were applied to the amplifier was immediately confirmed. Ever since that time this phenomenon has been known as "modulation product distortion." This seems a good descriptive term, and in the interests of uniform terminology in England and America may be worth being made known to your readers.

Fundamentally, "modulation product distortion" may arise in any circuit containing a rectifying element. This may be an overloaded tube, and may particularly easily be a tube or tubes operated with positive grid excursions, and it is best avoided by guarding against overloading and eschewing positive grid operation in audio-frequency amplifying valves.

Turning to "Cathode Ray's" suspicions that harmonic distortion may be tolerated in reasonable amount, may I say that in the United States I believe that it is the general opinion that up to 10 per cent. even harmonic distortion may not prove excessively objectionable, while 3 per cent. of odd harmonic distortion is distinctly annoying. In my own laboratories where we are engaged in designing radio receivers and amplifiers for presumably extremely critical musicians, we have learned to believe that much over 1 per cent. total harmonic distortion is disagreeably perceptible at ordinary home entertainment volume levels of up to 5 watts electrical amplifier output. Modulation product distortion is definitely more annoying even than a few per cent. of odd harmonic distortion, but this fact does not justify the designer in "white-washing" harmonic distortion. It is unfortunate that most sales departments, if not most engineers themselves, the world over consider the public to be afflicted with "tin ears," and, as the human ear relatively easily "conditions" itself to distortion in regularly repeated doses, the radio industry can take little credit for improving the general public's taste in tone quality.

To turn to another, but associated, subject, in the United States "high-fidelity" receivers have been offered capable of good reproduction up to 9,000 cycles. Upon the presumption of good transmitter modulation, such is of distinct tone benefit. Commercial considerations result in "deep" modulation by practically all American broadcast stations for commercial and economic reasons, with the result that for critical listeners such increased tone range is an annoyance rather than a benefit. I have observed over several years a condition which leads me to believe that this annoyance is traceable to harmonic distortion resulting from intermittent but regularly transmitted over-modulation. This is because, if reproduction be cut off sharply at 6,000 cycles, such distortion is not noticeably apparent, but becomes increasingly so above what might be termed the "threshold" of 6,000 cycles.

As a corollary I seriously question the importance of any frequencies in musical reproduction above 6,000 cycles as a result of tests conducted with skilled musicians of wide hearing range, as well as because of the tendency with increasing age of adult hearing progressively to reject higher tones.

Until such time as auditory perspective, binaurality, depth or third dimensional effects can be had in radio reproduction, I am inclined to feel that discreet amounts of both odd and even harmonic distortion may profitably be included in electrical sound reproducers as a means of simulating in some slight measure the three dimensional aspects of music so sadly lacking in radio reproduction. McMURDO SILVER.

Chicago, U.S.A.

Relays

MAY I apologise to your correspondent "C. G. J."?—I seem to have misled him. Relay companies, to the best of my knowledge, are not losing 90 per cent. of their subscribers. I meant to convey that 90 per cent. of those subscribers they did lose were well satisfied with the service they received. "PRAXIS."

"Amplitude Distortion"

I HAVE been very interested in "Cathode Ray's" article entitled "Debunking Harmonic Distortion" in your issue for May 19th, 1938, and in the correspondence between this gentleman and Mr. Benham and Messrs. Callendar and Clarke. The latter gentlemen entitle their contribution "Debunking Intermodulation." I have followed their example in summing up, in the title of this letter, what I feel about the matter.

Fundamentally, any system of measuring amplitude distortion must:—

(a) Measure the shape of the working input/output characteristic of the apparatus under test.

(b) Establish by experiment the relative "unnaturalness" (or, as Messrs. Callendar and Clarke call it, the "unpleasantness") of telephony transmitted through the apparatus in question.

(c) Establish by experiment the relation between "unnaturalness" of reproduction and a number of shapes of the input/output characteristic.

This is the process used in the work described in my *Wireless Engineer* paper. As a result a proposed standard of distortion was set up.

Referring to items (b) and (c) above, a large number of experiments must be made to cover many different types of telephony; for instance, (1) speech, (2) music and speech, (3) violin and piano, (4) orchestra and recitation, (5) organ and voice, etc., etc. These tests must be done on "high-quality" apparatus, in which a known degree of distortion can be introduced and switched in and out instantaneously, and which at any given time may be readily expressed in terms of the shape of the output/input characteristic. (I refuse to court misunderstanding by saying either harmonics or intermodulation products!) If this is done, particularly on such items as Nos. 1, 2, 3, and 4, it will readily be found that the greatest infidelity of reproduction exists when the input/output characteristic is such as to produce certain higher-order intermodulation products *when a certain test signal is fed into the apparatus.* Note

that these are side tones produced from the test signal; *they have nothing whatever to do with whether such side tones occur (or do not occur) in the telephony on which the experiment is made.* The experiment will also show that, whereas infidelity is more or less proportional to the behaviour of certain measured side tones, it is by no means proportional to the ordinarily measured harmonics of a sine wave. This is because the phase angles of the harmonics are not measured. Therefore in my *Wireless Engineer* article I suggested a standard of measurement of input/output characteristics (item (a) above) based upon measured side tone or intermodulation products.

It seems to me that there is a confusion in the minds of your correspondents between two quite separate things. It may be interesting to argue whether in the transmission of telephony the production of spurious harmonics or side tones is pleasant or unpleasant to the ear, and/or "increases with the order of harmonic." This is, however, quite irrelevant to the subject of amplitude distortion. Arguments about musical theory are beside the point. One never in any circumstances measures or evaluates any of the harmonics or side tones produced when, for instance, Donald Duck or Mr. Hibberd are speaking over the wireless. In fact, I am not aware of any apparatus capable of doing this. What we are concerned with is to note whether Donald Duck or Mr. Hibberd or the Symphony Orchestra sound unnatural or natural. We can then measure the shape of the input/output characteristic of the apparatus which is transmitting their respective sounds and thereby determine what particular shape makes them sound natural or unnatural.

Whether the shape of the input and output characteristics is evaluated by plotting a curve of the Eg against Ia, or by applying a sine wave and measuring the resulting harmonics, or by applying two sine waves and measuring the side tones is quite immaterial *so long as whichever system of measurement we employ shows up those properties of the input/output curve which vary in the same manner as the audible distortion or "annoyance value,"* and can therefore be used to measure this. Experimentally it has been found that side tones do have this property, and 2nd and 3rd harmonics of a single sine wave do not (because phase angles are not measured); but these side tones are side tones artificially produced during a test, and are nothing whatever to do with side tones which may (or may not) be produced when Mr. Hibberd, Donald Duck or the Symphony Orchestra are coming through the same amplifier. A lack of realisation of these facts seems to be the basis of the difficulties found by your correspondents.

It follows from the above that, so long as the shape of the input/output characteristic to be evaluated does not change with frequency, there is no reason whatever, as Messrs. Callendar and Clarke say there is, to make measurements "at all frequencies and at all output levels."

Experiments comparing the relative distortion of the transmission of any note or combination of notes are only relevant as regards that particular note or combination of notes. Therefore, for instance, the aural estimates of "pure tones" mentioned at the end of Messrs. Callendar and Clarke's letter can only mean something on those rare occasions when the B.B.C. transmit such pure tones. I do not recollect having heard an unaccompanied flute on the wireless, nor is one particularly interested in the question of the purity of reproduction of the time signal.

With reference to (b) of Messrs. Callendar and Clarke's letter, such a reading of my paper is, of course, quite wrong. The correlation between an upward turning 3rd harmonic accompanied by a downward turning 2nd harmonic, and the production of side tones, when the same valve is measured with two input tones instead of one, was merely mentioned as an interesting fact of use, perhaps, to those who did not possess the necessary apparatus to make side tone measurements. It is not my "criterion" of distortion. It merely gives, as I said in the *Wireless Engineer,* sometimes "quite a good idea."

I am surprised to note also from these gentlemen's letter that they agree with the idea of endeavouring to make their ordinary harmonic measurements fit the results they observe in listening tests by quite arbitrarily and artificially adding to (or "weighting") the amplitude of the higher harmonics in question. Has it escaped their notice that a measurement plus a guess is equivalent to a guess only? Any measurements can be made to fit any observed phenomena if the measurement is altered after it is made.

May I make a suggestion that it would be extremely interesting if your correspondents would all conduct a series of tests (as set out above) on a wide selection of different types of programme and will correlate each test with their own pet ways of measuring the shape of the input/output characteristics, e.g., side tones or higher harmonics, etc., and see which system of measurement gives figures most closely agreeing with the audible results? Naturally, the apparatus employed should be capable of giving really high-quality reproduction at the turn of a switch (as the control of the experiment). Distortion should be confined to a part of the circuit which is readily measurable; for instance, the loud speaker employed should be of the best possible type. Loud speaker amplitude distortion is difficult to measure and is frequently a source of serious errors in experiments of this type.

So far, I appear to be the only person who has yet published any complete results of tests on these lines. This is a rather unenviable isolation, and I can only request others to try such experiments for themselves before querying my conclusions.

J. H. OWEN HARRIES.

London, S.W.19.

Background Noise

IT may be of some interest to know that I have traced excessive background in my QA Super to noise developed in the cathode resistor of the frequency-changer. This was by-passed to RF only by a 0.05 mfd. condenser, and on increasing its capacity to 1 or 2 mfds. the noise was reduced to normal proportion.

It seems to me that this condenser should be large enough to by-pass any AF noise voltages that may be generated in the resistor, or, alternatively; a non-inductive wire-wound resistance should be used.

Since the function of this valve is modulation, surely any noise voltages generated in the bias resistance will cause modulation of the intermediate frequency.

This should not apply to amplifying valves with comparatively straight characteristics since modulation should not take place in these stages.

Derby. T. BALDWIN.

Readers' Problems

A Selection of Queries dealt with by the Information Bureau, and chosen for their more general interest, is published on this page.

Aerial Wire

A READER recently erected a new aerial using enamelled stranded wire, and having been told that RF currents are mainly confined to the "skin" of wires wishes to know if the insulation is detrimental; also would an improvement in signal strength be obtained by replacing it with bare wire.

So far as performance is concerned there is no difference whatsoever between bare and insulated wire for the aerial. Possibly a little more care is needed in the erection of an aerial when insulated and stranded wire is used, as if any joints have to be made it is essential that all the insulation be removed from the strands so that each one is securely soldered to the continuation lead.

If the solder fails to "take" on one of the inside strands this may rub against the others when the aerial swings in the wind and cause "crackles." Locating a fault of this kind is an extremely difficult matter as there is no visible evidence that anything is amiss with the aerial.

To guard against this the aerial and lead-in wires should be one continuous piece without joints of any description. Even with bare stranded wire the same care should be exercised if joints must be made. The insulation will, however, give some protection to the wire against the corrosive effects of town and seaside atmospheres.

Fault Finding

A PECULIAR fault has developed in a reader's receiver which is a battery set but operated by an AC mains HT supply unit. After the set has been working for a short time there is a sudden reduction in volume, accompanied by severe distortion.

Were it not for the introduction of distortion when the volume fell we would be inclined to suspect a break in the primary of the inter-valve transformer. A like fault in the secondary winding might account for it as the output valve will be operated without grid bias.

Other likely causes are a defect in the output valve, or in the HT supply circuit. One simple way of ascertaining if it is the one or the other would be to connect a voltmeter across the output sockets of the battery eliminator that supplies HT for the

last valve and note what happens when the distortion occurs.

If it is caused by a defective output valve or a fault in the anode circuit of the valve the HT volts will most likely rise. On the other hand, a fault in the eliminator will usually manifest itself as a reduction in the output voltage.

The location of the actual cause of the trouble will be rendered far easier by this simple test as it gives a reasonably good indication where one should look for the fault.

Wiring SW Sets

HAVING been told that in a short-wave set the wiring must be kept as short as possible, a reader asks for guidance on this matter, as it is obvious that *all* the connections in the set cannot be restricted in length to an inch or so.

The advice given to our querist is quite correct, though it should have been stated that the short wiring refers only to those leads carrying RF currents.

This comprises the leads between tuning condensers and coils, grid circuit wiring of RF and detector valves, reaction circuit wiring and the leads from the low potential end of the tuned circuits to the valve's filament or cathode.

After the RF by-pass condenser in the anode circuit of the valves leads may be any reasonable length, and the same applies to grid bias leads, though in the case of grid bias for an RF stage a by-pass condenser should be joined, by the shortest possible path, from the tuned circuit to the negative filament pin, or cathode, of the valve. If an RF stopping resistance is then connected to the "earthy" end of the tuned circuit the lead to the grid bias battery can be of any length.

An Uncommon Fault

AN intermittent fault in a wireless receiver is probably the most difficult of all to locate, especially after the obvious ones, such as loose contacts, dry joints, etc., have been eliminated.

In one particular case of this kind the set would behave normally for a time, then suddenly signals fell to bare audibility. Sometimes this was brought about by switching on an electric light in the house, and occasionally the fault could be cleared in this way.

Eventually the trouble was traced to a break in the primary winding of an AF transformer. Though it is difficult to say exactly what was taking place, a possible explanation is that the two ends of the wire were just touching, and any sudden surge of current, such as would be brought about by the "click" on switching on a light, caused a minute arc. This oxidised the broken ends of the wire, and when this arcing ceased the primary circuit was interrupted, as the thin oxide coating formed an insulator.

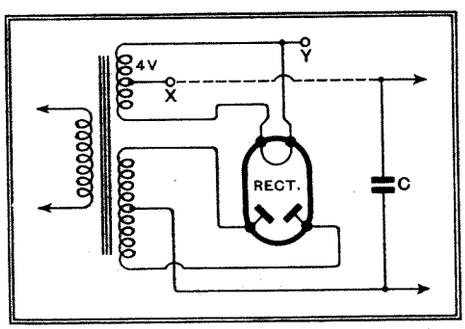
Slight vibration of the set might be sufficient to cause the ends of the wire to touch and so break through the insulation, thus completing the primary circuit.

This particular fault is an uncommon one, but in view of its illusiveness the likelihood of it being responsible should not be overlooked when all other possible causes have been eliminated.

HT Rectifier Connections

THE customary practice when wiring an HT rectifier circuit is to join the reservoir condenser across the centre tappings of the high voltage secondary and of the valve filament windings respectively. Occasionally, however, an alternative connection is made and the positive side of condenser C is joined to one end of the filament winding, that is to say, to Y instead of to X in the figure. A reader now asks if this is entirely satisfactory as he thinks that this arrangement might be more prone to produce hum and so require additional smoothing.

It makes no difference in practice which arrangement is adopted as joining the condenser C to the point Y is quite satisfactory. The ripple on the rectified output far and away exceeds the small difference in potential between X and Y, and this is



Reservoir condenser C in HT unit may be joined either to centre-tap on filament winding or to one end

completely smoothed out by the usual choke and condensers.

News from the Clubs

Exeter and District Wireless Society

Headquarters: 3, Dix's Field, Exeter.
Meetings: Mondays at 8 p.m.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

On July 4th the Society paid an interesting visit to the Exeter Gas Works. Regular meetings will recommence in September.

West Herts Amateur Radio Society

Hon. Sec.: Mr. A. W. Birt, 6, Hempstead Road, King's Langley.

On July 6th Mr. G. Martin gave a further talk in the series entitled "Television." His talk dealt with scanning. G3NR then described an interesting experiment carried out by himself and 2BZY on June 11th, when they took portable receivers to the top of the Ashridge Monument and made observations of reception, particularly of N.F.D. stations.

On July 9th the Society organised two exhibits at the West Herts Hospital carnival fête held at Berkhamsted. Both exhibits were linked by landline and visitors were able to send messages at the rate of 3d. for twelve words.

Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. R. Dowsett, 48, Grove Road, Eastbourne.

On June 27th Mr. W. A. Morgan, one of the members, gave Morse instruction. A demonstration of the Lissen Hi-Q short-wave superhet four was also given. It was decided that members should keep it on trial and send reports to the manufacturers. Mr. S. M. Thorpe then demonstrated a spark coil giving 60,000 volts output.

Romford and District Amateur Radio Society

Headquarters: Y.M.C.A. Red Triangle Club, North Street, Romford.
Meetings: Tuesdays at 8.30 p.m.
Hon. Sec.: Mr. R. C. E. Beardow, 3, Geneva Gardens, Chadwell Heath.

This Society has recently changed its name from the Chadwell Heath and District Amateur Radio Society and has moved to more commodious premises.

Radio Society of Northern Ireland

Hon. Sec.: Mr. H. F. Ruberry, 19, Little Victoria Street, Belfast.

The Leonard Trophy contest is to be held during October, and is open to all transmitting stations in the world. Particulars are as follows:—

The contest is open to all licensed transmitting stations. Licensed power must be used.

Only one operator allowed at each station; if more than one operator, each operator's score counts separately.

All stations must exchange R.S.T. reports to count for points.

Stations may be worked once only during contest.

All licensed frequencies may be used.

Dates and Times

Oct. 1st at 12.00 GMT to Oct. 2nd at 24.00 GMT.
Oct. 8th at 12.00 GMT to Oct. 9th at 24.00 GMT.
Oct. 15th at 12.00 GMT to Oct. 16th at 24.00 GMT.
Oct. 22nd at 12.00 GMT to Oct. 23rd at 24.00 GMT.

Method of Scoring

1 point for European contacts. 2 points for African contacts (N. of Equator). 3 points for African contacts (S. of Equator). 3 points for North American contacts. 4 points for South American contacts. 4 points for Oceania contacts.

Score of Irish station to be multiplied by the number of countries worked.

Districts of America W1 to 9 and Canada VE1 to 5 count as separate countries.

Awards

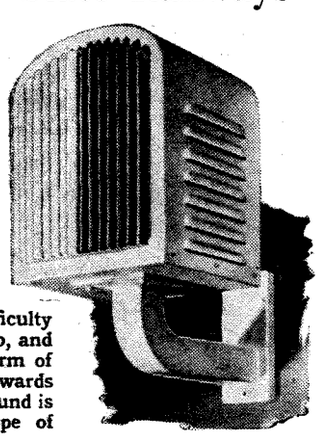
For the leading Irish station the Leonard Trophy will be awarded for one year (replica also).

For the leading station outside Ireland a gold medal.

For the second station outside Ireland a silver medal.

All logs must reach the Hon. Secretary R.S.N.I., H. F. Ruberry, 19, Little Victoria Street, Belfast, Northern Ireland, on or before December 31st, 1938.

PA for the German State Railways



SPEAKERS TO OVERCOME ECHO EFFECT

Special loud speakers have been designed by Korting, of Leipzig, for use (left) on platforms and (right) in waiting rooms. The chief difficulty in railway PA is the exaggerated echo, and this has been overcome by a special form of baffle which reflects the sound downwards along the length of the platform. Sound is deflected to the sides in this wall-type of speaker for waiting rooms.

Random Radiations

By "DIALLIST"

Encouraging Car Radio

THE B.B.C., one observes, is to do its best to popularise car radio. I am afraid that it won't do just the one thing which would give car radio the chance of becoming as popular in this country as it is on the other side of the Atlantic. What is that one thing? Why, just this. In school term-time the National transmitters serving England, Wales and Northern Ireland, and the Regional transmitters in Scotland, are either closed down or devoted to school broadcasts until 5 o'clock in the afternoon. In broad daylight the range of a car radio set must of necessity be limited, and it is no great fun for the owner of one of these sets to have to rely mainly on a few home medium-wave stations, the nearest of which may be a long way from the road over which he is journeying. As a rule, of course, there are certain foreign stations to be received, but it is to the home stations that the user of car radio should be able to look for his entertainment.

A Queer Position

It's rather a queer business when you come to think it out. The B.B.C. has no altruistic motive in helping to popularise car radio. To put it with brutal bluntness, it's your money they want. They see that the increase in their revenue from the receiving licence fees must become smaller and smaller as the saturation point is approached. But there still remains a pretty rich harvest to be gathered amongst those who own cars but have not yet installed radio sets in them. Every such car owner represents a possible extra licence, and therefore an addition to the B.B.C.'s share of the total receipts. But the situation now is that on account of its service to schools, towards the cost of which the education authorities apparently make little or no contribution, the Corporation is prevented from taking action that would undoubtedly result in a large increase in car radio receivers and therefore in its annual revenue.

It Could be Done

The whole business could easily be set right by proper organisation and a very simple rearrangement of the times of school broadcasts. I haven't checked up recently the amount of hours devoted during the week to these broadcasts—they have finished at the moment of writing, since examinations are in progress. The total time occupied by them used to be rather less than ten hours a week, and I don't suppose that it is much different now. It is manifestly absurd that to fit in ten hours of school broadcasting the entire Regional service in Scotland and the National service in other parts of the country should be out of action so far as the ordinary listener is concerned for 33¾ hours each week during term time. Wouldn't everyone be satisfied if the mornings only were given up to the schools, the special broadcasts starting, if necessary, at nine o'clock and going on till midday? Most schools begin their morning's work at nine, but nine-thirty might be chosen as a compromise, the close down being at twelve-thirty. In this way fifteen hours would be available each week for the schools, and if the broadcasts really are worth while they would very soon rearrange their time-tables to suit the new arrangement. The afternoons would then be free for broadcasting proper, and motorists would be assured that their car radio sets would give them the choice of at least two home programmes.

The News Bulletins

AMONGST listeners in all walks of life I find very little enthusiasm for the times chosen for the news bulletins during the summer months. They are given now at 6 o'clock (National), 7.30 (Regional), and 10 o'clock (National), and there is also a late news summary just before midnight from the Regionals. What I gather is that a large proportion of listeners don't get home from their work in time for the 6 o'clock bulletin, that at 7.30 they are either having their evening meal or indulging in outdoor recreation, and that they want to be in bed or on their way there before 10.25, when the last bulletin ends.

The late summary is intended mainly for those who have been to the theatre or to the second house at the cinema, and there are few complaints about the time chosen for it. Nine o'clock is to most people the best time of all for the main news bulletin. There is a strong feeling that that time should remain fixed and unalterable throughout the year. It seems to fit in pretty well with nearly everyone's doings in the ordinary way, and I am fairly certain that the load-curves taken by relay exchanges would show that at any season of the year the bulletin at this time attracted more listeners than any other.

Another Criticism

There is another criticism of the news bulletins which I've heard from many listeners. It is that even when the main news was given at 9 o'clock so many interesting "flashes" and talks on topics of the day are deferred until an hour later. How frequently does the 9 o'clock announcer say "Our observer was present at this event and a recording of his impressions will be given in the ten o'clock news"? In common with many, I should like to see not only the fixing of the hour for the main week-day news bulletin at 9 o'clock from year's end to year's end, but also an extension of the time allotted to it from twenty-five minutes to half an hour or even thirty-five minutes, so as to permit items of the kind that I have just mentioned to be included.

Time Flies!

BY the time that this appears in print we'll be within less than five weeks of the opening of another Radiolympia. It will be an exhibition very different from those that we have seen in the past, for, as you know, the music-hall shows have been cut out and television is to reign in their stead. It will be extraordinarily interesting to see what the effect of this is on the attendance figures. Frankly, I expect to see some reduction in the numbers, for those who in the past went mainly for the variety show will probably stay away anyhow, and television is now not the novelty that it was to those who live anywhere near London. Both the big stores and the local wireless shops have run so many demonstrations. But one thing is certain: those who do go to Olympia between August 24th and September 3rd will be genuinely interested in wireless and wireless gear.

It's Important

In former years I've commented on the fact that not a few stands seemed to be

TRAVELLING SERVICE DEPOTS

Repairs While You Wait

A SWISS firm has recently equipped three 2-ton Bedford vans for making calls at customers' houses, where broadcast receivers are repaired on the spot by the crews. In addition to service equipment, the vehicles carry PA apparatus, and are used for sound amplification at various gatherings.

populated mainly by young men who knew little or nothing about the goods that they were supposed to be displaying. If that sort of thing wasn't good enough in former years, it will be much less so under the new order of things, when a much larger proportion of visitors will be people who know what they are talking about. They'll want intelligent answers to their questions, and they won't be satisfied with sales patter learnt by heart.

Good Work to be Done

It is exceedingly important this year that the London Exhibition and the provincial ones which follow it should be so organised that they bring home to the man in the street the progress that has been made in the technique of wireless reception and the real meaning to him of new developments. In the past that sort of thing happened outside the Exhibition, for most of the lay papers had frequent radio articles dealing in a popular way with the technical side. Nowadays their wireless articles, such as they are, are mainly concerned with "microphone personalities" or real or imaginary (usually the latter) upheavals at the B.B.C. With a few exceptions, the lay papers are now giving their readers exceedingly little information on wireless matters, and it is, therefore, most important that Radiolympia and the other exhibitions should supply the deficiency.

Still Waiting!

TURNING through the file in which I keep my carbon copies of these notes, I find that on August 30th, 1937, I wrote "At last the reason for the long delay in inaugurating anti-interference legislation becomes plain. The Government is shortly to introduce a new Wireless Telegraphy Bill . . ." Nearly a year ago I wrote "At last"; nearly a year ago I wrote that the Bill was *shortly* to be promoted. All these months have gone by, but the sentences quoted above still describe the position. Shall we be very much forrader a year hence if the present rate of progress continues? It is true that the Bill will almost certainly have come before Parliament some time before that; but it is sure to meet with a great deal of resistance before it becomes law. A committee will no doubt be appointed to enquire into vested interests and one knows how protracted the proceedings of committees can be. There is a very definite need for a real speed-up, and it is much to be hoped that M.P.s of the kind who get things done will use their influence to see that dilly-dallying is ended and that steps are taken to give us the much needed anti-interference legislation right soon.

Cause for Divorce?

HERE'S the latest wireless story, received from a thoroughly unreliable source. A short-wave enthusiast was maddened by his inability to receive the 10.30 p.m. item from a certain American station, which he desired above all things to hear. Night after night the same story: no sign of interference until just about the time that this programme was due, then ear-splitting crashes that came to an end when the announcer was saying, "You have just been listening to . . ." and were no more heard till the next night. In desperation he strove, but without success, to track down the cause of this apparently deliberate jamming. Then one night he called to his wife, who was always on her way to bed at that time, to lend him a hand by moving a switch whilst he took certain readings. She descended, hairbrush in hand, and sat operating the switch with one hand whilst brushing her hair with the other. The mystery was solved! At every stroke of the brush there were crackles both from her hair and from the loud speaker. The down-lead of the indoor aerial passed through her bedroom and she was a woman of regular habits, always brushing her locks at the same time for fifteen minutes by the clock!

Answers to Correspondents

I CULL the following from the radio columns of a lay paper which is *not* published in this country:—

Question.—My wireless receiver was working perfectly when I switched it off the other night, but when I switched on the following day I could not obtain a sound from it. Can you please tell me what has gone wrong with my five-valve wireless receiving set?

Answer.—Yes, this is quite a common occurrence. What probably happened is that a discharge from a small unseen lightning flash reached the aerial and passed to earth through the interval (*sic*!) circuits, thus putting the set out of action.

I haven't much experience of "small unseen lightning flashes," but I think that the owner would have been in no doubt about what had happened if a hefty charge induced in the aerial by lightning had passed to earth through the receiving set. I have seen one or two to which this kind of thing had happened, and the damage was both extensive and obvious. Sets of mine—and, no doubt, of yours—have refused to work when switched on, though they had been performing perfectly up to the moment of the previous switching off. What I have invariably found in such circumstances is a dicky connection somewhere or a valve loose in its holder.

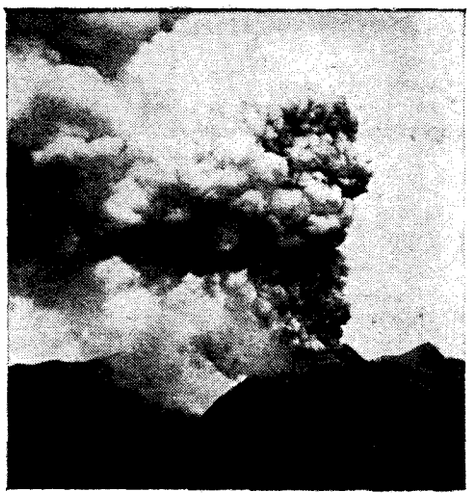
Not Good Enough

BEFORE now I have given you instances of the delays which people living abroad are apt to experience when they order wireless bits and pieces from firms in this country. Some people found them rather hard to swallow, but I can assure you that every one was authentic. And here's something that has happened—or, rather, which is still happening—to me. Three weeks ago I ordered from firm A a stock component priced at £2 10s. An invoice came a few days later and the money was sent by return. Despite reminders and telephone calls from me, and promises on the part of the firm to despatch at once, I am still minus that component. That's pretty bad; but how about the second transaction, this time with firm B? Wanting a measuring instrument of a certain type, I wrote to ask them whether they had one in stock and could deliver without delay. Their reply gave affirmative answers to both questions and quoted £2 as the price of the instrument. The £2 was sent twelve days ago and an acknowledgment duly received. But I haven't yet got that measuring instrument, though I have twice had apologies and assurances that it was on its way. That kind of thing just isn't good enough. Unfortunately, it's all too common and it is about time that some firms realised the harm that they do themselves and the industry in general by such dilatory methods.

VESUVIUS IN ERUPTION

LAVA ENGULFS VILLAGES

MANY DEAD



..that was in 1906!

When Vesuvius burst into violent activity in 1906, the whole world was horrified. Scores of villages were wiped out by white hot lava. Hundreds were killed. Thousands of tons of ashes were spread far and wide over the countryside. Vesuvius, alone, would have marked 1906 as a memorable year.

But, in another sense, 1906 was a memorable year. It was the year when T.C.C. was founded — the year when *today's* reliable radio *began to take shape*. For radio reliability is, largely, condenser reliability. And, for 32 years, T.C.C. have been making *reliable* condensers. That is why so many amateurs and set makers rely *exclusively* on T.C.C.

T.C.C.
ALL-BRITISH
CONDENSERS

THE TELEGRAPH CONDENSER CO. LTD.
WALES FARM RD. NORTH ACTON, W.3

525x

Recent Inventions

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

DIRECTION-FINDING

RELATES to a DF receiver of the kind used on an aeroplane to give a definite indication of the position of the machine relative to the centre line of two overlapping navigational beams. The arrangement can also be used for "homing" on a non-directional beacon station if the receiving aerial is periodically switched over.

Any departure from the straight-line course is usually indicated by the receipt, say, of a series of "dashes" if the deviation is to port, and a series of "dots" if the deviation is to starboard, these two merging into a continuous or unbroken "note" so long as the machine remains on the centre-line or correct track.

After rectification, the "dots" take the form of square-voltage impulses of higher amplitude than a datum line, whilst the dashes appear as similar variations of lower amplitude than the normal. These differently phased voltages are applied to a pair of push-pull pentodes, which are so biased that when one form of signal is received it "takes control" and inhibits any further response for a certain short period. In this way an unmistakable indication is given, whenever the pilot finds himself either to port or starboard of his proper course.

N. Y. Philips Gloeilampenfabrieken. Convention date (Holland) May 14th, 1936. No. 483427.

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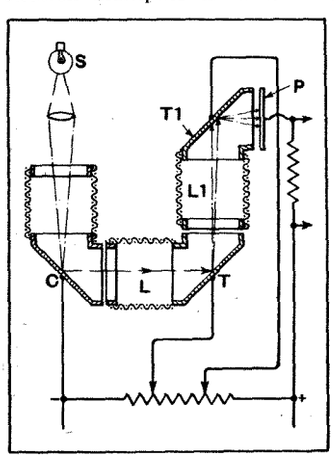
ELECTRON MULTIPLIERS

THE figure shows the electrode arrangement of a multi-stage electron multiplier in which the



Compact electrode assembly of multi-stage electron multiplier described in the text

focusing of the electron stream is effected wholly by electrostatic means, and without any external magnetic control. Light from a source S is projected on to a photo-sensitive cathode C, and the secondary electrons produced are focused, in succession, on to target electrodes T and T1. They are finally collected by an output plate P.

The tubes L, L1 act as electrostatic lenses and produce a sharp image, on each of the target electrodes, of the area over which secondary emission occurred on the preceding electrode. Each of the emitting electrodes is set so as to bend the stream through 90 deg., thus economising space and permitting the whole assembly to be mounted on a single glass tube.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.) October 25th, 1935. No. 483826.

o o o o

TELEVISION SCREENS

WHEN the fluorescent screen of a cathode-ray receiver is viewed by daylight, or under artificial illumination, the direct light from the picture is mixed with diffused light from the room which has been reflected back from the screen. This tends to reduce the "contrast value" of the picture, and also prevents its "shadows" from showing dead black.

According to the invention the proportion of the indirect light is reduced, relatively to the desired or direct light from the picture (a) by shielding the fluorescent screen as much as possible from the general illumination by means of a metal tube with a blackened inside surface, and (b) by interposing a "greyish" glass plate which absorbs more of the "diffused" light than it does of the direct light from the picture.

The General Electric Co., Ltd. and A. Bloch. Application date, November 6th, 1936. No. 483841.

o o o o

RADIO NAVIGATION SYSTEMS

THE landing ground at an aerodrome is equipped with a number of radio beacons, located, say, one at each corner and one in the middle of each side.

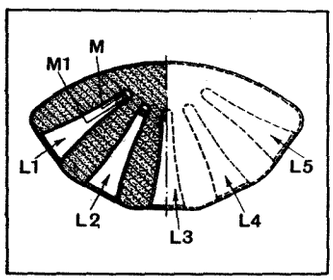
The aeroplane is fitted with a dipole aerial which is, in effect, made to "scan" the area of the landing ground. The aerial is mounted on a rotating shaft, which can also be moved axially, so that a to-and-fro and up-and-down scanning motion can be imparted to it. Since the dipole is highly directive in its response, it will receive at maximum strength each time it traverses one of the "marker" beacons on the aerodrome. The signal voltages are fed to the deflecting-plates of a cathode-ray tube, and produce a series of bright spots on the fluorescent screen which mark the outline of the landing field, even when the latter is hidden from direct observation by fog.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), July 6th, 1936. No. 483437.

o o o o

STEREOPHONIC REPRODUCTION

TO secure binaural or stereophonic reproduction, the stage of a theatre (or any other area from which sounds originate) is divided into, say, five "zones," to each of which is allotted a directional microphone unit consisting of two instruments, say, A and B. The output from each of the A instruments is fed in series into one line, whilst that from the B instruments is similarly combined in a second line, both lines



Loud speaker assembly for binaural reproduction.

being coupled to a loud speaker unit of the kind shown in the Figure.

This houses five separate speakers, marked L1 to L5, with diverging horns. Each instrument is energised by two piezo-electric elements, M, M1, separated by a block of sponge rubber, and fed respectively by the two supply lines from the battery of microphones.

The arrangement ensures a high ratio of direct to indirect or "reflected" sound, as well as maintaining the directional identity of each sound.

L. F. Savage and C. J. Francis. Application date, July 23rd, 1936. No. 483730.

o o o o

SHORT-WAVE RECEIVERS

THE Figure shows a circuit designed to handle a wide band of television frequencies.

The grid-cathode capacity of a valve not only tends to introduce positive reaction, but also offers a shunt path for very high frequencies, and so limits their amplification. It has already been proposed to insert an impedance between the cathode and earth so as to provide a negative feed-back; if the magnitude of the impedance exceeds a certain amount, the potential of the cathode is found to follow that of the grid, so that the output can be taken from the cathode circuit. Such an arrangement is known as a "cathode follower valve."

The valves V, VI, shown in the Figure are of this type, the output from V being applied across an inductance L to the input of valve VI. The negative feed-back is applied across the resistances R, the usual grid-bias being derived from resistances R1. Both valves contain screening grids, and each control grid is shunted by an inductance L of such value that it is tuned by the inherent grid-cathode capacity to the signal frequency, to which it therefore offers a very high impedance.

W. S. Percival. Application date, October 28th, 1936. No. 483744.

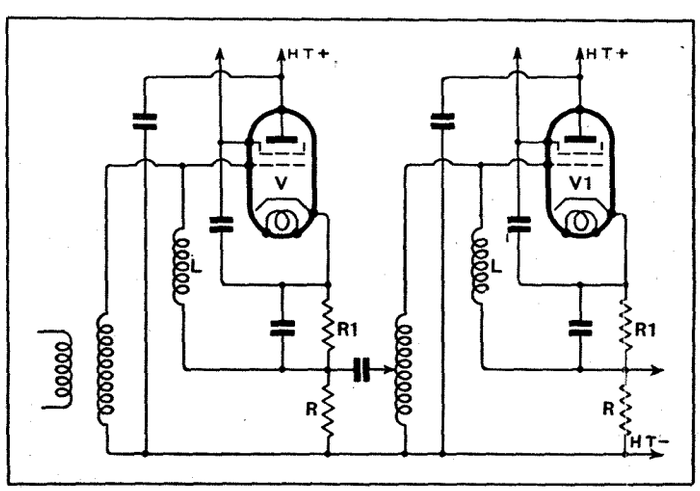
o o o o

WIRELESS CABINETS

A WIRELESS cabinet is made to simulate the appearance of a mantelpiece clock, the usual fretwork opening for the loud speaker being occupied by the face of the clock. Small pedestals raise the base of the cabinet slightly above the level of the mantelpiece, and the loud speaker works into an aperture formed underneath the base, where the opening is not seen.

The usual tuning and control knobs are located at the side of the cabinet, where they are screened from view by a hinged moulding, which can be swung aside to give access to them when necessary.

O. Raz. Application date, December 15th, 1937. No. 483700.



Amplifier for handling a wide band of frequencies such as is encountered in television.

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THE PRACTICAL RADIO JOURNAL
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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

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EDITORIAL COMMENT

Telephone Vision

Opportunity for Post Office Enterprise

THE Post Office is proverbially progressive and enterprising; there have even been occasions when we have questioned whether their enterprise has not exceeded the bounds permissible to a Government office enjoying monopolistic privileges. No one would, however, dispute the rights of the Post Office to develop and improve the telephone service, and it is in this direction that we suggest that there may be opportunity offered.

In Germany, for some considerable time, an experimental television service combined with the telephone has been successfully operated, and has preceded any attempt at a national television broadcasting service. In cities as far distant as 400 miles telephone booths have been established where, by appointment, friends can converse with one another and see each other at the same time. The cost has been kept at a very reasonable figure, which has encouraged patronage of the service.

To inaugurate similar services between London and large centres such as Manchester and Birmingham, where suitable cables may already be installed, would be an interesting new line of development for the Post Office promising a commercial return for the expenditure involved. It would not, perhaps, be essential in such cases where the subject televised would be large for the highest definition system to be adopted, and this would facilitate the extension of the service over less efficient lines. We imagine that such a service might prove extremely popular here, and it is certain that the publicity which such a step by the Post Office would give to television would encourage the public to take a keener interest in the service of television broadcasting.

B.B.C.

The New Appointment

SIR JOHN REITH'S successor has been appointed and so at last speculation on who would occupy his chair has come to an end. Broadcasting has had little contact with the new Chief, but his mental equipment and experience promise competence in his new sphere.

There are many who think that a Chief should have been found within the B.B.C. organisation and, therefore, more intimately acquainted with the machine which he has to control, but broad experience is no doubt of greater value than detailed knowledge of the broadcasting organisation now that the system is so firmly established. In any case, as we have pointed out previously on this page, the delay in settling the succession almost precluded the possibility of the appointment falling upon an individual within the existing organisation because the delay must inevitably have meant that candidates within the B.B.C. were in competition, each with his own following within Broadcasting House. It must be a great relief to the staff to know that the appointment has been made and that the new Chief has neither friends nor enemies in broadcasting, if only by virtue of having had no broadcasting contacts prior to his appointment.

The new Chief has our sincerest good wishes for success in his new duties, which will exact from him a continuation of that devotion to public service which has already marked his career to its present stage.

Reflection of Wireless Waves

IT is believed that reflections of waves from levels a few miles above the earth's surface and within the boundaries of its atmosphere are due to irregularly distributed "clouds" or patches, rather than to the presence of a layer. Investigations into this matter are described, and the author concludes that low-level reflection is unimportant in explaining transmission phenomena, though the structure of the higher true ionospheric regions was found to be such that television signals might at times be reflected from them.

By J. H. PIDDINGTON, M.Sc., B.E.

LOW-LEVEL "CLOUDS" AND THEIR EFFECTS

A LITTLE more than a year ago Mr. R. A. Watson Watt[1] described in these columns the discovery of ionised layers at heights above the earth from about five to nine miles, which strongly reflected wireless waves. It was suggested that these layers had a reflection coefficient of about 0.7 and that they would be effective in causing fading and unexpectedly long transmission paths of ultra-short-wave signals, as well as multiple images in television pictures within the service area of the television transmitter. (By the "reflection coefficient" of a layer or patch is meant the ratio of the strengths of the signals returned from the layer or patch to its strength if returned from a perfectly reflecting infinite plane surface at the same distance from the transmitter.)

The E and F Layers

It was at once realised by ionospheric physicists that if these highly reflecting strata really did exist, then most of our ideas concerning the propagation of wireless waves to great distances would need radical revision, for since 1926 it has been customary to regard such communication as generally being effected either by way of Region E in the case of long waves, or by way of Region F in the case of the shorter waves. However, an examination of the original communication of Watson Watt and his co-workers[2] in which they present the arguments leading to the conclusions outlined above made two points clear. First, the results themselves shown in the form of photographs of the cathode-ray oscillograph screen were undoubtedly reliable, and of the greatest scientific importance; for, although earlier investigators claimed to have noticed reflections from this low-lying region, the evidence produced did not appear conclusive. Secondly, the interpretation of the results appeared open to considerable doubt, and in the light of further investigations that have been made it is felt that this interpretation must be radically altered.

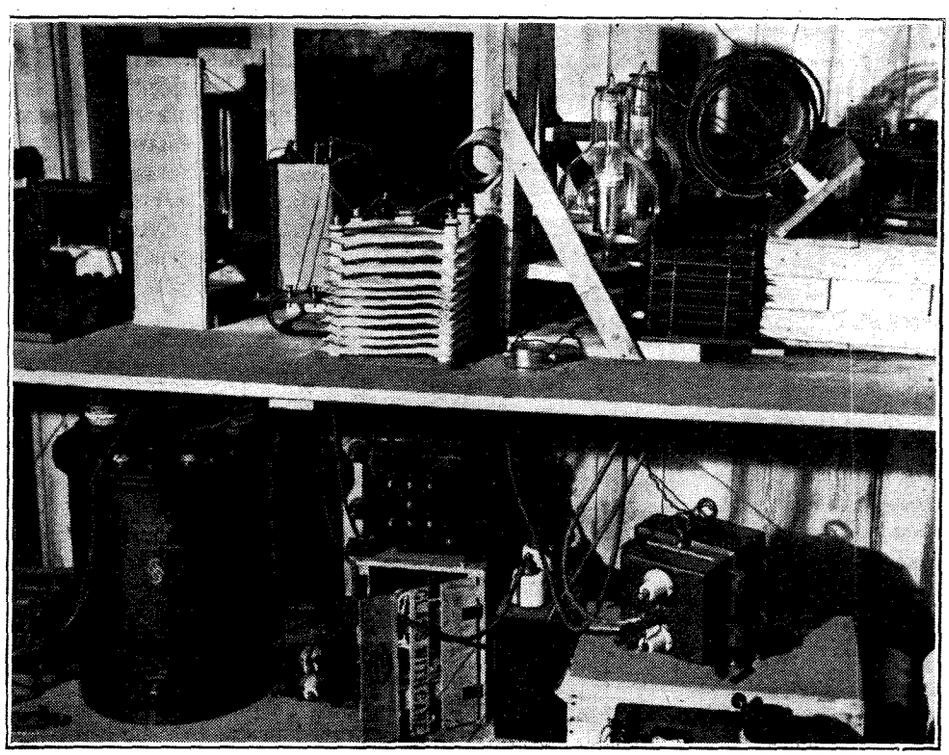
In a recent paper,[3] Professor Appleton and the writer describe the results of an investigation on reflection coefficients of ionospheric regions, during which they paid special attention to these "low-level" reflections. Before discussing the results, however, it might be of some interest to mention the type of apparatus necessary to undertake such an investigation.

The well-known "pulse" method of investigation was used in which very short duration signals are sent out at regular intervals. The wave travels the short distance from the transmitter to the receiver, and is registered by the fast-moving spot of a cathode-ray oscillograph. A little later the wave reflected from the ionosphere arrives and this "echo" also makes its mark. The height of the layer from which reflection takes place is obtained by multiplying half the time delay of the echo by the velocity of the wave. In the case of reflection from a level of five miles, the time delay involved is only about fifty microseconds, and therein lie the experimental difficulties. Since the echo cannot be detected while the powerful direct ray continues to arrive at the receiver, the latter must be completed within fifty microseconds of its starting.

A portion of the transmitter is shown in the accompanying photograph. Below are the power supplies, the high-tension unit giving up to 15,000 volts. On the left is the modulating equipment which supplies a grid bias to the main oscillating valves of −2,000 volts, this high value being required to stop them oscillating quickly at the completion of a pulse.

Generating the Pulses

Methods used for generating the modulating pulses are rather interesting. Electrical methods are the most successful, although some workers have successfully used semi-mechanical methods, one being the use of a switch in the form of a small steel ball swinging between two plates. In the transmitter here described gas-filled triodes were used to generate the pulses. The fast upstroke of the pulse occurs when this type of valve strikes, and the duration of the pulse is determined by the time-



The powerful transmitter used in making radio "soundings" of the atmosphere.

[1] R. A. Watson Watt, *Wireless World*, March 5th, 1937.

[2] R. A. Watson Watt, A. F. Wilkins and E. G. Bowen, *Proc. Roy. Soc.* A. 161, p. 181 (1937).

[3] E. V. Appleton and J. H. Piddington, *Proc. Roy. Soc.* A. 164, p. 467 (1938).

Reflection of Wireless Waves—

constant of a resistance-capacity circuit. When the pulse is due to finish a second valve strikes and forms a short-circuit across the impedance in which the pulse voltage has been developed. The method has been developed by several workers[4] to its present form.

The pulse, which is almost perfectly square-topped, is then amplified suitably and fed to the grid of a 250-watt modulating valve. While the grid of this valve is at the same potential as its cathode it passes a current of $\frac{1}{4}$ amp. which flows through a resistor of about 8,000 ohms and causes a grid bias of $-2{,}000$ volts to be impressed on the main transmitting valves. During the pulse the grid of the modulating valve is at -200 volts, and the valve is non-conducting. There is, therefore, no bias on the oscillators and the transmitter operates.

The oscillators with their associated tuned circuit are to be seen on the right of the photograph. The oscillatory circuit is heavily damped and feeds a half-wave horizontal dipole by means of a matched feeder. The power supplied to the oscillators during the pulse was 8 kilowatts, although they were actually rated at 250 watts; the power delivered to the aerial was about $2\frac{1}{2}$ kilowatts and the pulse lasted 20 microseconds.

It is inevitable that a pulse in passing through a receiver must have its duration increased, but this effect is decreased if the band-pass characteristic of the receiver is made wider. The receiver used had an overall band width of 66 kilocycles per second, and even this resulted in a lengthening of the pulses from 20 to 50 microseconds, which was, however, tolerable.

Distinguishing Weak Echoes

The above apparatus was calibrated to determine the weakest reflections it would be capable of "seeing." This calibration depends on the power of the transmitter, and sensitivity and noise level of the receiver. Obviously if a given receiver is used with two transmitters the combination which can "see" the weakest reflecting layers is that where the more powerful transmitter is employed. The calibration is simply done by observing the first and second reflections from the F region and noting the weakest echo which is distinguishable above the noise level. This gave sufficient data to show that a layer at a height of six miles, with a reflection coefficient of 0.0001, would give an echo capable of detection. No such echoes were observed in a period of three months, from which it was concluded that the reflections, if any, from this region correspond to reflection coefficients of less than one in ten thousand.

Since the experimental results obtained by Watson Watt and his co-workers appeared to indicate conclusively the presence of some reflecting agency at distances of the order of six miles from the transmitter, further efforts were made to obtain reflections. By the courtesy of Mr. Watson Watt the receiver mentioned above was used in conjunction with the very powerful transmitter used in the original investigations and reflections were obtained. The coefficient of reflection was found under normal conditions to be between 0.00002 and 0.00007, and it is believed that the reflecting agency is not in the form of a layer at all, but occurs rather as irregularly distributed patches or blobs. Signals returned from these low levels are designated as "B region" echoes, this nomenclature being adopted in order that the reflections (also very weak) which Watson Watt, Wilkins and Bowen, as well as other workers, have obtained from heights of about 30 miles may be classed as C region echoes. The D region may then be thought of as between about 37 miles and 56 miles, although its properties and composition have yet to be determined. A further upward trend leads us to the E, or Kennely-Heaviside, region, which is too well-known to need further reference at present, although its "fine structure" will be discussed later.

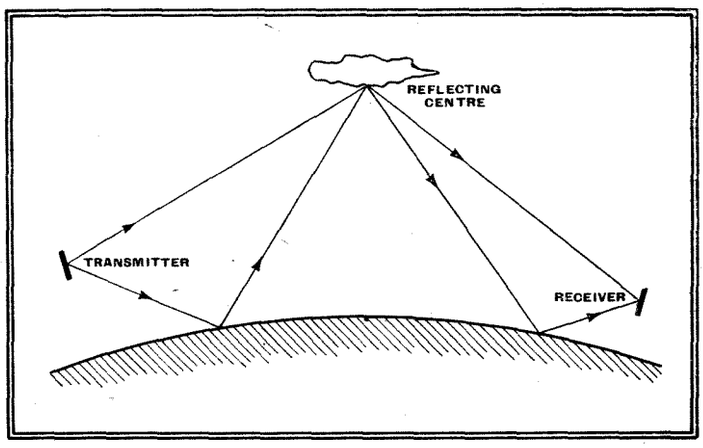


Fig. 1. Showing the four ways in which a signal may pass from transmitter dipole to receiver dipole via the reflecting centre. The wave which passes directly over the ground is not shown.

Further tests were carried out in connection with the B region reflections at television wavelengths. Using the Alexandra Palace transmissions, ghost images were occasionally seen when the receiver was 43 miles from the sender. Most, and perhaps all, of these were found to be due to aeroplanes. A typical ghost image occurred one inch away from the main picture, which was ten inches wide. This meant that the echo arrived about 9 microseconds after the ground signal, so that the path difference for the two rays was 1.7 miles.

The influence of B region on television signals may be easily calculated if we assume the reflection coefficient found for 6 mc/sec. waves to hold for 45 mc/sec. waves. It is at least very unlikely that the reflection coefficient will be greater than 0.00005, so we will adopt this figure for our calculations.

It is at considerable distances from the transmitter that such reflections would most easily be seen, and an example has been worked out in which the distance from the transmitter to the receiver is 43 miles, and the B region reflecting centre is half-way between the two. Now, as shown in Fig. 1, there are four separate ray paths along which signals may travel via the reflecting patch to the receiver. It is easy to show that if the height of the patch is about three miles or more, then the path difference of the rays which travel direct to the patch and those which travel to the patch after being reflected at the ground is quite large compared to a wavelength. It is, therefore, possible to so adjust the position of the reflecting centre that both rays arriving at the patch are in phase, and that both rays which leave the patch arrive at the receiver in phase, the field strength thereby being increased by a factor of 4.

The field strength, E, in volts per metre at the receiver is given by the following formula:

$$E = \frac{0.79\sqrt{P} \times r}{d}$$

where P is the power transmitted in kilowatts

r is the reflection coefficient of the B region patch,

and d is the total path travelled in miles.

This formula refers only to the waves which are reflected in B region. It includes the factor of 4 due to phase addition of the various waves, and includes an allowance of four decibels due to the directive characteristics of the Alexandra Palace aerial. If we put $P=3$ kilowatts, which is the mean power transmitted on the vision channel from Alexandra Palace, and $d=43$ miles, we find the field strength to be 1.5 microvolts per metre.

The Ground Wave

The wave which travels directly over the ground may be estimated from the theoretical curves published by T. L. Eckersley,[5] and when allowance is made for bending due to the atmosphere the field strength is found to be about 80 microvolts per metre. We should hardly expect, therefore, even under the most ideal conditions, to be able to see B region echoes at this distance, and at shorter distances the strength of the wave which travels along the ground will be even stronger compared to that which is reflected from B region. This is in accord

[4] S. H. Falloon and G. Millington, *Marconi Rev.*, Nov. 1935.

[5] T. L. Eckersley, *Journ. I.E.E.*, 80, p. 286, (1937).

Reflection of Wireless Waves—

with practical observations, as the propagation of ultra short waves to well beyond the line of sight is, in general, adequately accounted for by diffraction or the curving of the waves around the earth, and by refraction or the bending of the waves in the atmosphere near the earth's surface.

The propagation of waves of length less than 10 metres over distances of thousands of miles must be due to reflection at F region, and their reception within the "skip-distance" of this layer is probably due to reflection by the small densely ionised clouds occurring inside the normal E region, which will now be described.

The powerful pulse transmitter which was described above has been used by Prof. Appleton and the writer in a detailed investigation of the properties of these E region scattering centres. They find that the reflection coefficients, while much larger than that corresponding to B region, are still small, seldom rising above 0.05 and generally being less than 0.005. There appear to be two types observable at frequencies as low as 9 megacycles per second, but at television frequencies we might expect to find only one type, and these appear to indicate the entry into the atmosphere both by day and night of cosmic particles which produce bursts of ionisation of very great intensity. The second type of scattering centre found in E region probably has a solar origin and does not produce patches of such dense ionisation.

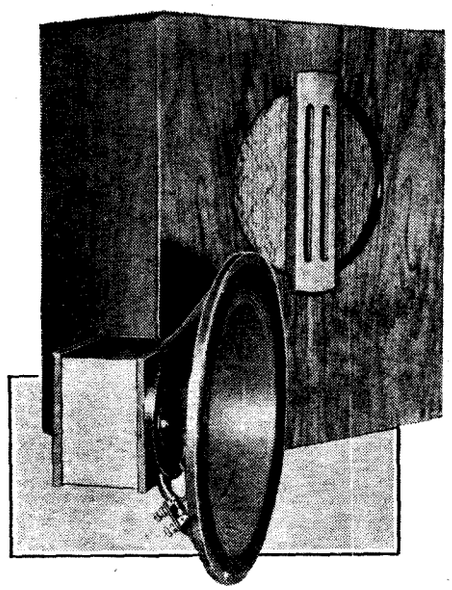
The importance of these E region scattering centres, as far as the establishment in England of several television stations operating on the same wavelength is concerned, might be considerable. A calculation along similar lines to that which was made above in reference to Fig. 1 suggests that field strengths of the order of 50 to 100 microvolts per metre might be obtained at a very considerable distance from the transmitter. This is, however, completely neglecting the radiation diagram or directivity of the television aerial, and careful design in this respect would, at least to a great extent, overcome the difficulty.

The way in which the patches of ionisation are distributed throughout the E region is rather interesting. They are found as low as 50 miles, and above this level they occur more and more frequently until a height of about 70 miles is reached. At still greater heights the frequency of occurrence decreases steadily until very few only are noticeable at heights of 120 miles. This distribution is curiously similar to that found for the intensity of aurorae, which are also caused by the entry into the earth's atmosphere of particles which are able to cause ionisation.

New Wharfedale Loud Speakers

TWO new models have recently been added to the range of Wharfedale loud speakers. Both are PM types with massive square section "Alnico" magnets rated to give a flux density of 14,000 lines per square centimetre.

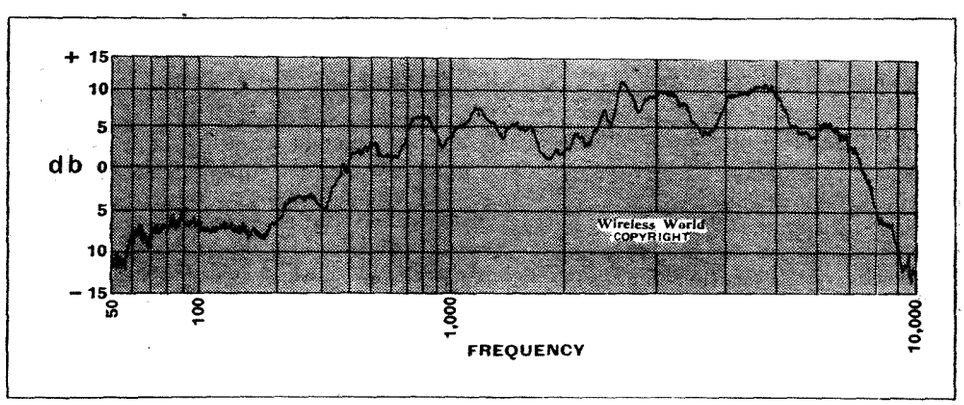
The "Portland" auditorium chassis is fitted with a 9in. diaphragm of the concentrically corrugated type which has been so successfully applied in previous products of this firm. It will be seen that the frequency characteristic is remarkably level up to 7,000 cycles and that there is no serious diminution of output up to 10,000 cycles. The powerful magnet gives excellent damping, and the reproduction has that firmness of tone and clear separation of component parts in music which is the mark of a well-designed instrument. There is no obvious fundamental resonance in the bass, and the powerful magnet gives a high electro-acoustic efficiency in addition to the more important advantages of critical damping. The price is £4 10s. or £5 5s. with transformer.

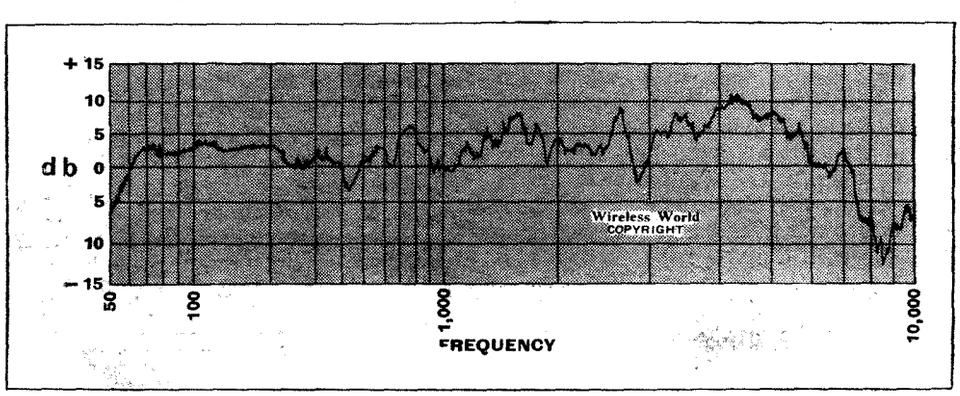


Wharfedale "Portland" chassis and "Langham" cabinet loud speaker.

The "Langham" cabinet model is an interesting design, for it has a unit with a "free-edged" cone and a totally enclosed back. Sound-absorbing material is disposed inside the cabinet to suppress internal reflections at high frequencies, and the characteristic has been given a general rise from 50 to 4,000 cycles to allow for the change of reverberation with frequency in the average living room. Under normal conditions of use there certainly seems to be far more bass in the general balance than the out-of-doors curve would suggest. Over most of the frequency range the forward response is at the same level as the "Portland" chassis with a similar magnet, but on account of the suppression of the radiation from the back the general efficiency of the "Langham" appears to be somewhat lower. The difference is not serious, however, and the loud speaker is one which will make an excellent adjunct to the better class of receiving sets. The chassis alone with free-edged cone costs £5 10s., and the complete "Langham" cabinet baffle with the same unit, £8 10s. An output transformer can be supplied in either case for 15s. extra.

The makers are Wharfedale Wireless Works, Hutchinson Lane, Brighouse, Yorks.





(Above) Axial response curve of Wharfedale "Langham" cabinet loud speaker. Microphone distance 4 ft., input 1 watt.

(Left) Axial response curve of Wharfedale "Portland" chassis. Microphone distance 4 ft., input 1 watt.

Band-Spread Tuning

By H. B. DENT

SIMPLIFYING THE CONTROL OF SHORT-WAVE RECEIVERS

WHY tuning is inherently so much more difficult on short than on medium or long waves is clearly explained in this article. Mechanical and electrical means of overcoming the trouble are described.

OF the many problems that arise in the designing of a short-wave receiver, few present so much difficulty as the tuning arrangements. It is not the mechanical side of the business that troubles one so much as the electrical, for as the frequencies are so much higher than we have to contend with on the medium broadcast waveband, quite a small variation in the capacity of the tuning condenser results in a comparatively large change in frequency.

For example, a 0.0005 mfd. (500 m-mfds.) condenser tuning a medium-wave size coil may cover a band of 1,500 to 550 kc/s, 200 to 550 metres, or a change of 950 kc/s. In this ether space can be accommodated about 100 broadcast stations, and if the dial is engraved 0-100 we get approximately one station, or station channel, per division. With a dial of about four inches in diameter the actual movement of the condenser spindle for a dial-change of one division is extremely small, and quite a good slow-motion drive is needed to make the tuning-in of stations reasonably easy.

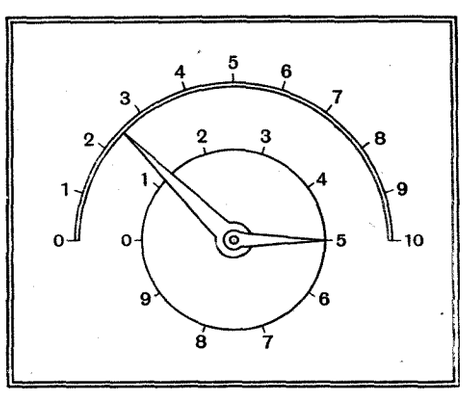


Fig. 1.—Mechanical band-spread: in conjunction with a suitably geared drive, the use of main and subsidiary scales permits the accurate recording of tuning settings.

Let us now examine the conditions obtaining on, say, 20 metres. If we use the same size condenser and merely change the coil it would be possible to cover a band of frequencies of from, say, 15,000 kc/s to 5,500 kc/s. Note that the ratio of the lower to the higher frequency is the same as on the broadcast band previously mentioned, but this now represents a frequency coverage of 9,500 kc/s, giving room for 950 stations, and with our 0-100 division dial nearly ten stations will be crowded into each division. Obviously, the tuning will be very critical.

Needless to say, the usual practice is to reduce the size of the tuning condenser, and one of about 160 m-mfds. or smaller is generally employed. Even with a condenser of this size we can get a frequency coverage of, for example, from 15,000 kc/s to 7,250 kc/s—20 to 41.5 metres. In the process we will have somewhat improved the true tuning range as the stray capacities will almost certainly be smaller and the effective capacity change will consequently be relatively larger.

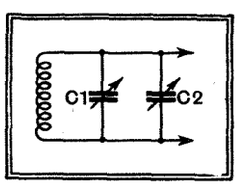


Fig. 2.—Electrical band-spread by means of a parallel-connected condenser.

Even this very drastic reduction in the size of the condenser has only lowered the actual band of frequencies coveraged to 7,750 kc/s, still giving about seven stations, or station channels, of 10 kc/s in each division on the dial. The tuning must inevitably be just seven times more critical than on the medium waveband. In order to achieve the same conditions the frequency band will have to be limited to 950 or, say, 1,000 kc/s, but then the waveband covered by a full rotation of the condenser will be only from 20 to 21.4 metres. Obviously, this is quite impracticable, as, to cover a range of 12.5 to 80 metres only, dozens of coils will have to be used.

On the short wave, therefore, a compromise is necessary. One way out of the difficulty is to reduce the size of the variable condenser to 100 m-mfds., fit a really good slow-motion drive and take more care in the tuning.

If one examines the short-wave region it will be seen that there are many areas having no real interest to the average listener, and only quite small bands are occupied by broadcast and amateur stations, the remainder being used by commercial services of one kind or another.

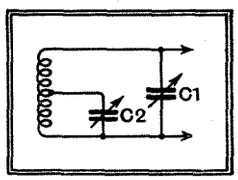


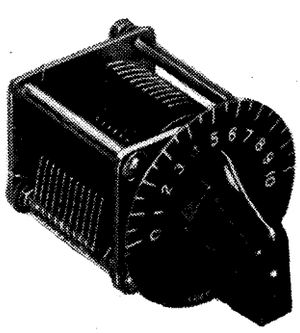
Fig. 3.—In this arrangement the band-spread condenser C2 is connected across a part of the tuning coil.

Broadcasting is confined mainly to six well-defined areas, commonly referred to as the 21, 17, 15, 11, 9 and 6 Mc/s bands, while amateurs have use of frequencies in the region of 28, 14, 7 and 3.5 Mc/s, in addition to some frequencies just below the medium broadcast band and comprising 1,715 to 1,925 Mc/s, which in the true sense is hardly a short-wave band.

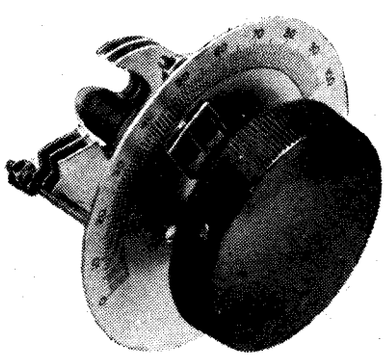
Alternative Systems

The question that now arises is how can one cover this enormous band of frequencies with a reasonable number of coils, or ranges, and at the same time make it possible to tune over the useful portions of the band in such a way that stations can be logged on the dial with a reasonable certainty of repetition?

There are two schemes in general use; one is described as mechanical and the other as electrical band-spread. In mechanical band-spread advantage is taken of the slow-motion driving mechanism to provide a vernier or subsidiary pointer having its own scale. If the gear-down ratio is 20 to 1 the driving knob makes ten complete revolutions for one half-revolution of the condenser spindle. Now by having a main pointer travelling over a scale engraved 0-10, as shown in Fig. 1, and arranging for the second pointer to traverse another scale, similarly engraved, the smaller will make one complete revolution for a travel of the larger of from, say, 0 to 1 on the outer scale.

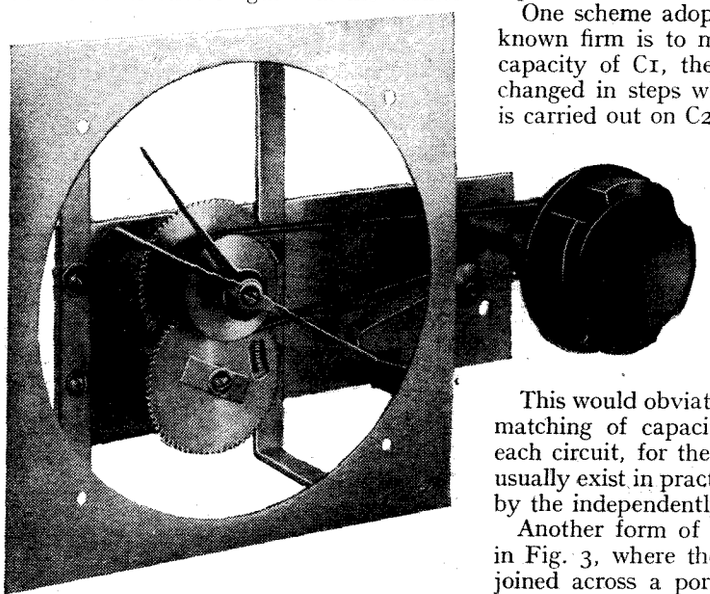


Component parts of an electrical band-spread system. The condenser on the left is variable in steps and the intervals are covered by the vernier unit on the right. It is made by Eddystone.



Band-Spread Tuning—

If the vernier scale was made the same diameter as the outer, the result produced would be equivalent to fitting a scale having twenty times the length of the 0-10 scale. Thus, if this is 6 inches long we obtain an effective length with the vernier of 10 feet. By choosing different ratios from those taken for this example even longer effective scales can be produced.



A dial made by B.T.S. that embodies the mechanical band-spread feature. The single-ended pointer makes eight complete revolutions for one half-revolution of the double-ended one. This actually follows the movement of the condenser shaft.

Though there are many variations of it, this is the basic idea of mechanical band-spread. It demands a very good slow-motion mechanism, which must be entirely free from slip or backlash.

Electrical band-spread is quite different, and for this is employed another tuning condenser which is usually of much smaller capacity than the main one. In its simplest form the small vernier, C2, is joined in parallel with the larger, C1, as shown in Fig. 2, being provided with a separate scale and driving mechanism.

One scheme adopted by a certain well-known firm is to make C2 one-tenth the capacity of C1, the capacity of which is changed in steps while the tuning proper is carried out on C2.

In an amateur short-wave set one could fit independently controlled C1 condensers in each of the tuned circuits, and employ a ganged assembly of small band-spread condensers.

This would obviate the need for accurate matching of capacity and inductance in each circuit, for the small differences that usually exist in practice would be corrected by the independently tuned units.

Another form of band-spread is shown in Fig. 3, where the vernier condenser is joined across a portion only of the coil. While with this arrangement both condensers could be of the same capacity, the band-spread unit C2 is best made only just large enough to cover the required waveband.

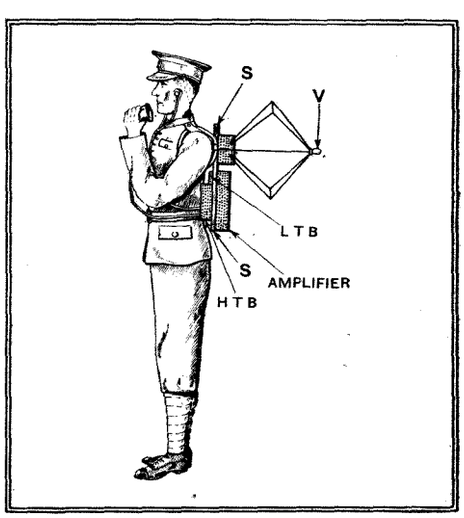
One advantage of this system is that the actual frequency coverage obtained with C2 can be made large or small merely by moving the tapping point on the coil. It is thus possible to fix the tapping on different range coils so that the portions of the range it is required to expand can just be covered by the band-spread condenser. This enables the greatest benefit to be derived from the system.

USW in the Field

AN interesting feature of a transmitter-receiver designed for military use and shown in the accompanying sketch (Patent 462529) is the use of a "split" frame aerial, the sides of which have a large surface area per unit length. This ensures maximum efficiency both as a radiator or receiver, particularly when the size of the loop is small relatively to the wavelength handled.

The harness of the set is equally convenient whether the soldier is standing upright, or crawling forward under fire, or lying prone. In fact, the only position the wearer cannot adopt is that of lying on his back. Also the front view of a man so equipped is not noticeably different from that of his fellows, so that he runs no special risk of being sniped by the enemy.

The amplifier stage and the filament and high-tension batteries are mounted on opposite sides of the lower end of a vertical panel S. The aerial is secured to the top of the panel, a cross-bar underneath being held by the shoulder straps. The valve V shown at the apex of the aerial is, in practice, enclosed in a protective casing. It is back-coupled through the inductances formed by the two sides of the split aerial, and is modulated for transmission, and "quenched" for super-regenerative reception. Stethoscopes are used in place of the usual headphones. The overall weight of the outfit is less than 20lb.



Transmitter-receiver operating with a split loop aerial. The valve at the apex of the loop functions as an oscillator for transmission and as a super-regenerative detector for reception.

Engineering Electronics. By Donald G. Fink. Pp. 358 with 217 Figs. McGraw Hill, Aldwych House, Aldwych, London, W.C.2, 1928. Price 21s.

THE "hard" valve (in American, "high-vacuum tube") is by far the most widespread and well-known electronic device; in fact, the author of this book estimates, from the number of valves in the average American receiver, and the number of sets in use, that there are more valves than inhabitants in the United States. But in the last ten or fifteen years other electronic devices which have been discovered are rapidly acquiring practical importance, not only for strictly "wireless" purposes, but in other applications, such as the familiar neon sign, and for industrial processes such as colour matching by photoelectric cells.

In "Engineering Electronics" the author begins by describing the fundamental properties of the electron, and its behaviour in electrostatic and magnetic fields, both in vacuo and in the presence of gas (e.g. Neon) or of vapour (e.g. Mercury, Sodium). As far as possible, this explanation is physical rather than mathematical, and is plentifully illustrated with curves showing the results graphically, so that it is fairly intelligible even if the "maths" is "skipped," although such "skipping" is scarcely necessary, since only school algebra and trigonometry are involved.

Commercially produced electron devices are then described; there are chapters on high-vacuum valves, gas-filled valves and Thyratrons, photoelectric cells, neon and other gas-filled electronic light sources, and a chapter on miscellaneous specialised devices such as cathode ray oscillograph tubes and television transmitting tubes (the "Iconoscope" and the Farnsworth "Image dissector").

The book concludes with four chapters on applications; to "power" purposes (mercury-arc rectifiers, grid-controlled and otherwise), to wireless and telephony, and to industrial control. These chapters are illustrated with outline diagrams of connections which enable the principles to be followed much more easily than if full details of components, etc., were given, of the "home constructor's set" variety. The author, in his preface, says that he has tried "to steer a course between simple descriptions of equipment on the one hand and elaborate technicalities on the other"; we think he has succeeded in this aim. C. R. C.

The Wireless Industry

McMichael, Ltd., have introduced an AC/DC version of their Model 380, illustrated in our issue of June 2nd.

The uses of "Silentbloc" vibration-absorbing mountings for protecting radio apparatus in aircraft, etc., are described in a well-prepared illustrated booklet issued by Silentbloc, Ltd., Victoria Gardens, Ladbroke Road, Notting Hill Gate, London, W.11.

The Sinclair Speaker works are closing down for the annual holiday from August 1st to August 7th, both days inclusive.

Home Recording

By HUMFREY ANDREWES, B.Sc., A.M.I.E.E.

PART III.—THE DISC AND THE STYLUS

HAVING described the general principles of direct home recording and the machines in general use, the author now turns to a discussion of the all-important matter of the discs or recording blanks. The various different types available to the amateur are described and the different treatments they require are explained in this article.

IN the first two articles of this series the general principles of lateral disc recording and the mechanical details of the machines used for direct recording have been discussed. We now turn to a consideration of the general requirements of the blanks on which the records are to be cut. It may be mentioned in passing that in strict gramophone parlance the record is the recording on one side of a disc, and when we refer to a disc we strictly are speaking of both sides in the case of a double-sided commercial pressing. This may perhaps sound pedantic, but the distinction can be important in purchasing pressings.

As has been previously explained, in the manufacture of the commercial gramophone record the recording is made on a wax blank. When such a wax is played back immediately, as a test for the artists and recording engineers to hear before the final wax is made, it is, of course, being used exactly like a direct record. Such a playing renders it useless for the manufacture of a matrix, and, for this reason, it is common practice in commercial recording studios to record two waxes simultaneously so that one may be played back and the other used for the matrix if the recording is passed. Except for experimental work, where a record is only played once or twice at the most, material as soft as wax is obviously quite unsuitable for making true direct gramophone records unless some hardening process can be evolved so that the wax can be played a number of times without damage.

Disc Material

We therefore arrive at the requirements for a suitable material for the direct recording blank. It must be initially soft enough so that a clean groove of the correct depth may be cut and at the same time must be hard enough, or must be capable of being hardened quickly, so that it may be played back a large number of times without the walls or bottom of the groove being damaged by the replay needle. Such requirements were not easy to obtain in the early stages of the development of direct recording, but in the past few years a number of blanks have come on the market, and it is now possible to cut a record which has a lower surface noise level than any shellac pressing, and which can, under favourable conditions, give a very high degree of fidelity, and yet can be reproduced using a straight steel needle well over one hundred times. A few years ago this would have been regarded as impossible, but intensive research has been carried out on the preparation of the recording disc.

In considering the subject of direct recording, and recording blanks in particular, it is interesting to note that the original records made by Edison were, of course, direct recordings, as they were made on a cylinder covered with thick tinfoil, and the hill and dale system was used. The recorder was, of course, used to reproduce the recording, and some of the early home recorders were worked on a similar principle, except that an aluminium disc was used instead of a tinfoil cylinder and the lateral system employed. It might not be out of place, in view of this, to give here some further details with regard to Edison's original phonograph. A patent was taken out for it in December, 1877, and the cylinder carrying the tinfoil was mounted on the lead screw, while the recording diaphragm was kept fixed. The lead screw was driven by hand, and a flywheel was mounted on it to keep the speed steady. We see, therefore, that the principles on which the modern gramophone recording machine works were to be found in Edison's original talking machine invented sixty years ago, and that this machine was probably the first direct-recording apparatus.

Probably the simplest and cheapest recording blank available to the experimenter is the plain aluminium disc. Aluminium is normally used as it is fairly soft, but a groove cannot be cut in it in the strict sense as in the case of the wax blank, and hence a conical cutter is often used which pushes rather than cuts a groove, which is normally about one- or two-thousandths of an inch deep. Such a groove has a very poor shape, and the record is played back with thorn or fibre needles, and the surface noise is rather high. Such records have a fairly short playing life, but if cost and simplicity are the most important factors, and a long life is not required, as in the case of experimental recordings, there is no doubt that the plain aluminium disc has its uses. Copper blanks have also been tried, and in the case of both metals the cutting is materially assisted by lubricating the disc with oil or grease before the recording is made, and by leaving some oil or grease on the disc the surface noise may be reduced and the playing life increased.

At an early stage in the development of direct recording it was realised that the plain aluminium disc had serious drawbacks, and considerable research work has been done in this country, on the Continent, and in the United States to develop a disc which would not only have a longer life, but which could be cut in a similar manner to the commercial wax recording blank, and a large number of different types are now available to the experimenter.

Types of Disc

These discs fall into three main classes. First, those which have as their base an aluminium or zinc disc coated with a suitable compound on which the actual recording is made, the metal base only being used to support the compound. Secondly, discs having a base consisting of a thin sheet of glass, suitably coated; and thirdly, those which are homogeneous and usually flexible and consist entirely of the material on which the recording is cut. There is also a fourth class, which was at one time available in the United States, but not, it is believed, in this country, which was pre-grooved—that is to say, a plain spiral was already cut in the disc, which was of a semi-soft material, and hence no tracking mechanism was necessary in recording on such blanks. This latter type was, however, as might be expected, not very satisfactory, and such discs are not now available.

Taking now the first class of disc, these are usually coated with a cellulose compound, and there are a number of different makes on the market. There is also a type which is coated with a plastic material, and these have to be subjected to a heat treatment after recording, when they become extremely hard. All the types of disc having a metal base have the great advantage that they are unbreakable, but can, of course, be bent, and all discs should always be carefully examined for flatness before being used, as otherwise a light and heavy track will be produced if there is a serious bump at any point.

In examining the disc it should be borne in mind that a sudden rise and fall of the cutter head and stylus is far more serious than a gradual one, and may even cause the point of the stylus to leave the disc altogether and leave a gap in the track. A method often adopted for checking the flatness of the disc is to place it on the recording table, and, while it is rotating,

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observe the reflection of some stationary object, such as the tracking arm or the slide of the tracking mechanism and see how much the reflection moves. If the movement is slight and gradual the disc is satisfactory, but if the movement is sudden, even though it is not great, the recording on such a disc may be unsatisfactory, particularly if the movement observed is at the edge of a twelve-inch disc. Naturally, imperfections in flatness are most noticeable in large-diameter discs, and, as a rule, there is very little trouble with discs of ten inches and less in diameter. As explained in the section dealing with recording machines, some manufacturers dish the turntable, so that when the centre clamp is pressed down on a disc having an aluminium base, any small unevenness is taken up. A suitable washer must be fitted when other types of disc are used. The writer has found that, as a general rule, discs having a base material other than aluminium cannot be dished in this way, particularly those with a zinc base.

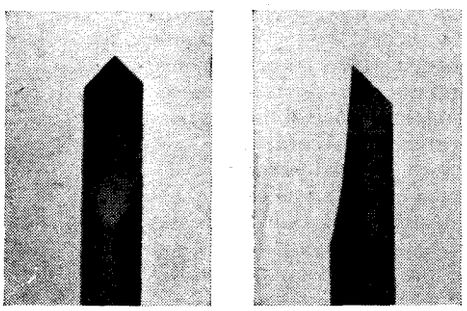

Fig. 1.—Two enlarged views of a steel cutting stylus.

In all types of metal-base discs the cellulose or other coating should be fairly thin, so that the walls of the groove cut in the disc are well supported by the metal base. Although this type is usually subjected to a hardening process, the coating is still resilient to a certain extent, and, therefore, if the coating is not fairly thin the walls of the groove tend to give under the pressure of the replay needle on large amplitudes, and also where the velocity is high, with subsequent losses. All discs of this type also show a loss in the reproduction of the higher parts of the frequency spectrum compared with the shellac pressing, and this "disc loss" must be allowed for in considering the characteristic of the recording head and amplifier. The cellulose type of disc may be cut with either a steel or sapphire recording stylus, and the swarf is often white or pale blue in colour. Some makes of disc, however, have a dark brown or black swarf.

Hardening Processes

A special hardening fluid is often recommended by makers, and the experimenter should follow the instructions given for different types of disc. A light lubricating oil is included in most hardening fluids for this type of disc, with the result that the finished disc is greasy to the touch. If left for a considerable time the disc may become dry, and it should then be rubbed over with hardening fluid to relubricate the grooves.

Turning now to the second type of disc, in this case the coating is of a gelatinous nature, and a hardening process is essential if a number of playings are required, although it may be played immediately in experimental work if the disc is not required to be kept. The hardening process takes slightly longer than in the case of the cellulose type, but this is not normally important. The finished disc is slightly harder than those of the previous type, with the result that, under favourable conditions, it is possible to obtain a slightly louder record and some improvement in the higher frequency response. As a glass base is used for this type of disc, it is claimed that a more uniformly flat disc is produced, but there is, of course, the disadvantage that the disc is breakable, although no more so than the familiar shellac pressing. A sapphire stylus must always be used for cutting this type of disc.

Finally, we come to the homogeneous type of disc. These are cut in a similar manner to the cellulose kind, but they are usually flexible, and it is therefore sometimes more difficult to get them to lie flatly on the recording table, with the result that a light and heavy cut is obtained on the edge of the disc. These discs are, it is believed, widely used on the Continent and do not require any hardening process, although a little lubrication is again an advantage. These discs may also be cut with a steel or sapphire stylus.

As mentioned in the first article in this series, a number of these discs may be used as master recordings from which matrices may be made, from which shellac pressings can be taken, and it may be stated here that the cellulose type is most suitable for the purpose. Up to the present time the second type has not been found satisfactory for this purpose. Where it is desired to use the disc for the manufacture of a matrix, it is usually better not to use any hardening process, and although the master may, of course, be played, great care should be exercised in this operation.

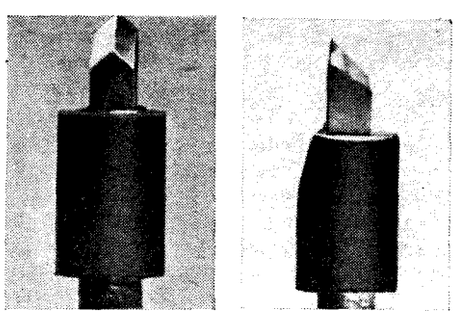

Fig. 2.—Two views of a typical sapphire stylus; note the angles of the different faces.

Before leaving the subject of the disc itself it might be mentioned that as there are now a variety of different makes of disc available, all of which have their advantages and disadvantages, and as the final word has not been said by a long way, it must be left to the experimenter to try the various different discs and choose the one which best suits his particular purpose.

We now come to the question of the actual stylus with which the groove in the disc is to be cut. In the first article in this series it was explained that, owing to the nature of the material to be cut, the shape of the groove in a directly recorded disc differs from that of the commercial pressing, and photomicrographs of the two types of groove were shown. It is obvious, therefore, that we shall find that the shape of the point of the cutting stylus is different for the two types of recording. Figs. 1 and 2 show typical shapes of steel and sapphire direct-recording cutters. In the majority of cases the direct-recording stylus has sides at 90 degrees, and the stylus ends in a very sharp point, whereas the wax sapphire is rounded. The set-off angle, as it is called, is usually 45 degrees, so we see that the point is triangular in shape. This can be clearly seen in the photographs.

Stylus Life

A number of different steel and sapphire styluses are available to the experimenter, and the success obtainable with different makes of cutter depends largely on the accurate formation of the actual point. As a general rule, the cutting life of a steel stylus is comparatively short, and with some makes averages about three to six twelve-inch sides. This type of stylus has, however, the advantage that it is comparatively cheap, varying between threepence to ninepence per stylus. For the experimenter this is perhaps an important point, as so often the stylus is damaged accidentally, due to errors in the operation of the tracking mechanism, that the cost of the cutting stylus can be a serious financial item.

The sapphire stylus, on the other hand, normally has a much longer life, and thirty or forty twelve-inch sides can often be cut with one stylus, but as they are more expensive and vary in price from three to fifteen shillings, accidental damage must be avoided. It may also be stated that the second class of disc mentioned above can only be cut with a sapphire stylus, and hence greater care must be taken when using this type of disc. It is always desirable to test the stylus before any important recording is undertaken, particularly in the case of the steel type.

A method often adopted, if a high-power microscope is not available to check a batch of styluses, is as follows: Using a carefully selected disc, an unmodulated cut about one-eighth to a quarter of an inch wide is made with each stylus, and then these cuts are played back under standardised conditions. Such conditions depend naturally on the equipment used. The author has found that in any serious work it is very desirable to determine definite playback conditions so

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that at any time the level and degree of surface noise between different recordings can be compared. If the apparatus is adjusted so that a fair amount of surface noise can be heard when a new high-quality shellac pressing is played, and the level always adjusted to give a predetermined reading on the volume level indicator using a constant frequency disc, then the quality of a given cutting stylus can be readily determined, provided, of course, that it is first known that the test disc which is being used is itself satisfactory. Conditions may, of course, be such that for normal playback the surface noise is excessive, as it is only possible by exaggerating such faults that the best possible results, using any given type of disc and cutting stylus, can be obtained.

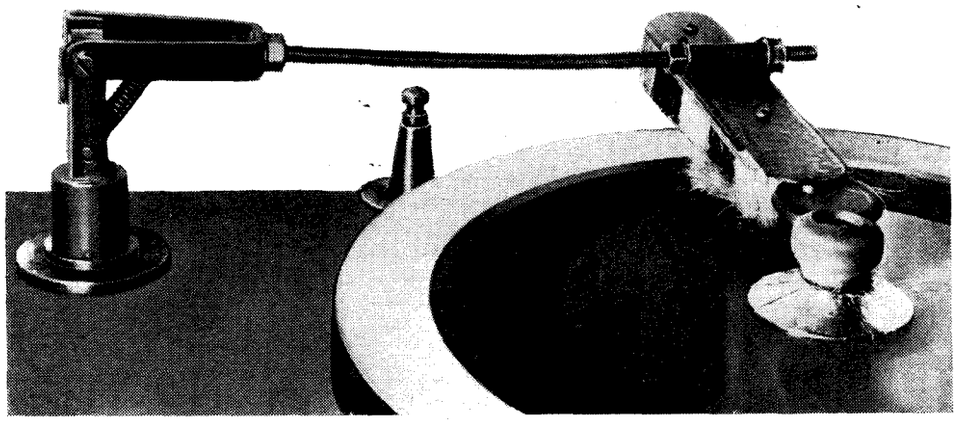


Fig. 3.—Swarf brush; note the eccentric wheel at the end of the brush-holder driven from the centre clamp.

Surface Noise

The author has found it convenient to divide surface noise due to the cutting stylus into three grades—A, B, C—with the use of a plus and minus sign for intermediate grades. Thus, for given playback conditions, an A surface is good, a B surface is moderate (about equal to the average commercial pressing), and a C surface is definitely poor. An A plus surface is occasionally met where, even under the most exacting conditions, scarcely any surface noise can be heard. Such discs should always be kept for demonstration to one's friends. It need hardly be added that the playback needle must be above suspicion for such tests.

When all types of direct recording disc are cut correctly a thin thread of the disc coating comes off from the cutting stylus and is known as swarf. If this swarf is allowed to collect behind the stylus or in a circle on the disc without attention it is very liable to cause cutting faults, and may even lift the stylus from the disc and give complete breaks in the track. This trouble is particularly serious with gelatinous type of coating, as in this case the swarf is considerably stronger than the cellulose type, and may cause damage to the point of the sapphire stylus. Some method of dealing with this swarf must, therefore, be evolved, and it will not be out of place to outline here some of the methods usually adopted.

Taking first the cellulose type of disc, the thread of swarf as it comes away from the stylus is often electrostatically charged, and, therefore, tends to cling closely to the surface of the disc and often follows the line of the previous groove cut. The simplest way of dealing with this swarf is to brush it with a soft brush, about an inch wide, and cause it to collect round the centre clamp. A little practice is required to acquire the requisite skill, but, although simple, it is perhaps rather a tedious process and makes the recording of a programme or item requiring monitoring rather difficult if one is single-handed. A simple automatic brush has therefore been evolved by one manufacturer, and is shown in Fig. 3. In order to keep the brush moving over the surface of the disc it is mounted on a pivoted arm in a similar manner to a pick-up and an eccentric wheel driven from the centre clamp causes the brush to oscillate to and fro. The swarf collects under the brush and then collects round the centre clamp.

Unfortunately, owing to the electrostatic charge on the swarf in the case of the cellulose type of disc, it cannot be removed by suction as is done in the case of the thread of wax from the commercial wax recording machine. The suction method can, however, be adopted in the case of the gelatinous coating. Suction plant is a somewhat expensive item, and some brushing method will therefore appeal more, perhaps, to the experimenter. A brush similar to that already described is, however, not satisfactory, as this type of disc is softer and can readily be marked, and must not even be touched by the hand before it has been hardened. A pad of soft material such as flannel or cotton-wool makes a good substitute, although even this produces a mark on the disc. Marks produced in this way on the disc do not, however, affect the surface noise appreciably, but tend to spoil the appearance slightly. If suction is not used, therefore, with this type of disc, brushing with a soft brush by hand must be resorted to, and as the swarf forms a good ring round the disc when the cut is correct, with a little practice this can be done satisfactorily. Most manufacturers recommend that the stylus should be set at a slight angle to the radial line of a disc so that the swarf tends to be thrown towards the centre of the disc, but this angle must not, of course, be too great or the groove cut in the disc will be distorted.

News from the Clubs

Dollis Hill Radio Communication Society

Headquarters: Braintcroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

On July 12th members discussed the accurate measuring of transmitter efficiency, and this was followed by a discussion on receivers and transmitters installed and used in mobile W/T stations.

Romford and District Amateur Radio Society

Headquarters: Y.M.C.A. Red Triangle Club, North Street, Romford.
Meetings: Tuesdays at 8.30 p.m.
Hon. Sec.: Mr. R. C. E. Beardow, 3, Geneva Gardens, Chadwell Heath.

Among members there are now nine with full transmitting licences and thirteen with artificial aerial licences. Several further applications are pending.

Bootle and District Amateur Transmitting Society

Headquarters: 368, Stanley Road, Bootle, Liverpool, 20.
Meetings: Tuesday evenings.
Hon. Sec.: Mr. C. E. Cunliffe, 368, Stanley Road, Bootle, Liverpool, 20.

Meetings are at present being held in the temporary headquarters, the address of which is mentioned above. Persons in the district are invited to write to the hon. secretary for a membership application form.

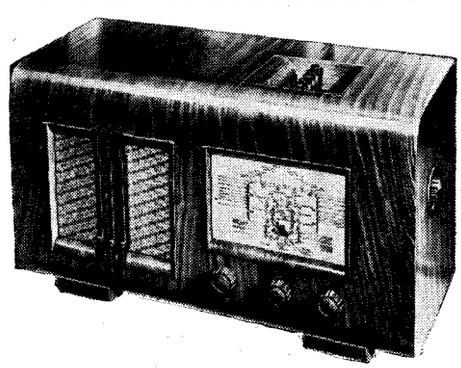
North Manchester Radio Society

Headquarters: 14, Fairfax Road, Prestwich, near Manchester.
Meetings: Alternate Sundays at 3.30 p.m.
Hon. Sec.: Mr. R. Lawton, 10, Dalton Avenue, Thatch Leach Lane, Whitefield, near Manchester.

Regular meetings of the above society are now being held on alternate Sundays, commencing at 3.30 p.m., the rooms being available for use of members from 3 p.m. The membership fee is 5s. a year, payable in two half-yearly instalments of 2s. 6d. A charge of 3d. is also made at each meeting. The meetings so far fixed are as follows:

August 14th and 28th, September 11th and 25th, October 9th and 23rd, November 6th and 20th, December 4th and 18th. More dates may be added later, and arrangements will be made for members to visit various places of interest.

TWO NEW BURNDEPT RECEIVERS



In their latest Models 298 and 299 Burndept, Ltd., provide press-button mechanical tuning in addition to continuous tuning over a range of 13.5 to 580 metres and 750 to 2,000 metres in four bands. A five-valve superheterodyne circuit is used in each case, the battery Model 298 having a separate oscillator instead of a power rectifier to make up this number. A permanent magnet loud speaker is fitted in both models and the price for AC or battery operation is 10½ guineas.

NEWS OF

THE NEW D.G.

Professor Frederick Wolff Ogilvie

ONE of the London newspapers on the day of the appointment of Dr. Frederick Wolff Ogilvie as Director-General of the B.B.C., had, as a poster topic, "Why Ogilvie?" We would ask, "Why not?" Surely it cannot be expected that the appointment of a successor to Sir John Reith would at once meet with general approval. It certainly came as a surprise, for, although his name was one of the first to be mentioned for the post, he was little known to the man-in-the-street.

Dr. Ogilvie, who is at present President and Vice-Chancellor of Queen's University, Belfast, has had a distinguished academic career, both at Edinburgh University, where he was from 1926 to 1934 Professor of Political Economy, and, latterly, at Belfast. He will not take up his new duties until October 1st, so that the B.B.C. will have been without a D.G. for three months.

There has been much speculation on the question of the salary of the new Chief, but the amount, variously stated at from £6,000 to £10,000 per annum, is fixed by the Board of Governors, who made the appointment.

TAIL BIGGER THAN DOG

Work Beginning on Broadcasting House Extension

A START is about to be made at clearing the site now occupied by Nos. 10-22 inclusive, Portland Place, London, W.1, for the erection of the extension to Broadcasting House. The demolition of the existing buildings, and clearing the site, will occupy several months, during which time detailed planning will be completed. It is hoped to have the building ready for occupation towards the end of 1940.

The extension as planned has a volume slightly in excess of the existing building. The architectural treatment, which has been approved by the Royal Fine Art Commission, will continue and amplify that of the existing façade to Portland Place. The extension is planned as an office building above ground-floor level, with a control suite on the seventh floor, and a restaurant on the eighth floor. A light court will occupy the centre of the structure. Below ground level will be accommodated a general purposes studio 80ft. by 54ft. by 30ft. high, three dramatic studios, an effects studio and a number of rehearsal rooms. It has already been announced that the architects are Messrs. Val Myer and Watson-Hart, F.F.R.I.B.A., and Messrs. Wimperis, Simpson & Guthrie, F.F.R.I.B.A., in association with Mr. M. T. Tudsbery, M.Inst.C.E., the Civil Engineer to the Corporation.

FILM RECORDING

Increasing Use in Broadcasting

THE B.B.C. recording staff are showing an increasing tendency to resort to the use of the film track for recorded programmes. The principal reason is that cuts can be made more easily with this method than with any other. Freedom from hiss, provided the film is kept spotlessly clean, is another important advantage.

It is probable that film tracks may be used for the repetition of the Empire programmes in the near future.

Film Tracking the Loch Ness Monster

On Monday last, July 25th, a venturesome little party, headed by John Pudney, the B.B.C. producer, sallied into the open at Fort Augustus with a mobile recording van to capture something of the aura of mystery which has hung over Loch Ness since 1933, when the Monster splashed into the headlines for the first time.

Wax recordings of interviews with "eye witnesses" are to be blended in a feature programme which will be re-recorded on a film track for broadcasting to Regional listeners on August 21st.

NEW AMERICAN NETWORK

Scheme for Linking Up Individual Stations

TO supply the thirty-two million American set-owners with broadcast material, there are 728 transmitting stations, almost half of them being linked up with either the N.B.C., the C.B.S., or the Mutual networks. Of the remaining stations, 387 in number, the majority are strung across the country supplying independent broadcasts over local areas.

The problem of welding these stations into a profitable independent system has twice been handled unsuccessfully, three years ago by the Trans-continental Broadcasting System and, more recently, by Airways, Inc.

Now a new effort is being promoted by the Western Radio Union, a subsidiary of the well-established Western Newspaper Union, which serves 10,000 newspapers with syndicated material. The new system would embody a coast-to-coast network, primary coverage being rural areas. Much of the material broadcast would be in the form of electrical transcriptions, which offer a flexibility essential to isolated stations.

It is expected that the system, which is to be designated by the letters W.R.U., will be operating in the autumn, and eventually it may have the largest membership of any of the existing systems.

RESULTS OF RECENT A.A.A. Championship races at the White City were for the first time relayed to the scoreboard by means of this portable 3-metre transmitter.

BERLIN EXHIBITION PRE-VIEW

Televisors for the German Public

FOR the first time in Germany television receivers will, at the annual Radio Exhibition, be available to the public. They will cost about Rm.600 (approx. £50) for television reception only, or about Rm.850 for a combined television and all-wave receiver. It is also expected that large-screen reception on a 50 cm. sq. screen will be attempted.

Other items of interest which will be seen at the Show, which will remain open longer than usual (August 5th to 21st) include a new mains receiver at about half the price of the old Volksempfanger, and a new edition of the original "People's Set," incorporating a moving-coil loud speaker.

A giant theatre, seating some 4,000, for the performance of a Radio Revue, will be a feature of the Show.

FRENCH NEWS SUPPRESSED

Unpopular Muzzling of the Broadcast Word

AS was recently reported in these pages, the time allocated to broadcast news bulletins from French State and private stations has been reduced from one-and-a-half hours to twenty-one minutes. This drastic treatment is the result of applications made to the Government by the National Federation of Newspapers, and it has aroused serious protests from general public, various wireless associations and even from a certain section of the Press.

The Federation has published an official statement repudiating any responsibility for the suppression, pointing out that the object of its demands was to revise the hours of broadcast news bulletins so as to prevent them from coinciding with the release of newspapers. It is expected that the subject will be brought before the Government for further consideration.

SHORT WAVES AT PORTSMOUTH

SHORT-WAVE transmitters on a modern cruiser and a destroyer will be used on Saturday (July 29th) for commentaries on the naval activities which begin Portsmouth's Navy Week. A receiving station on shore will relay signals to the B.B.C.'s mobile broadcasting van, whence they will be

THE WEEK

"piped" to Broadcasting House.

The principal commentary falls to Thomas Woodrooffe, who will describe from Nelson's *Victory* typical scenes in the dockyard around. Assisting him will be two staff commentators, one on the cruiser and the other on the destroyer.

STANDARDISED CONCERT PITCH

DURING the recent summer meetings of the International Broadcasting Union a technical committee reported on its studies into the acoustic qualities of the note "A" which is used internationally as the tuning note for orchestras. Conditions of temperature in different parts of the world affect the pitch of identical tuning forks, and the problem of standardisation will probably resolve itself into frequency measurement. The committee proposed that the matter should be treated in conjunction with the International Acoustic Committee at the earliest opportunity.

FROM ALL QUARTERS

Malayan Short-wave Station

SIR SHENTON THOMAS, Governor of the Straits Settlements, last week opened the new short-wave transmitter of the British Malaya Broadcasting Corporation, which will operate on 30.96 metres.

Cable for Radiolympia Television

INTERFERENCE during the televising of Bertram Mills's circus from Olympia last January has led to the decision to use a cable link for the Radiolympia transmissions, which begin on August 24th.

Popularity of Radio in India

THE increasing popularity of wireless in Baroda, India, where the Government of the State has recently sanctioned the sum of Rs. 150,000 for the construction of a broadcasting station for the State, is evidenced by the increase in receiving licences which recently numbered 419 as compared with 247 a year ago.

New York Television Exhibition

IN Radio City, New York, the National Broadcasting Company has installed a permanent television exhibition. This includes, in addition to apparatus and exhibits, a large, glass-walled studio from which performances being televised can be seen by visitors.

Radio Exhibitions

IT might be of interest to readers to have for reference purposes the following list of radio exhibitions arranged in date order:

German.—Berlin, August 5th to 21st.
British.—Radio Manufacturers' Association, Olympia, August 24th to September 3rd.
Polish.—Warsaw, August 27th to September 11th.
French.—Grande Palais, Paris, September 1st to 11th.
Belgian.—10th Salon de la T.S.F., Brussels, September 3rd to 13th.
Swiss.—National Swiss Fair, Lausanne, September 10th to 25th.

Portable Police Communication Set

THE South African Police has sponsored the construction, by an amateur, of a portable two-way transmitter receiver. It uses a wavelength of 4.5 metres, weighs 10lb., and has an effective range of up to 15 miles.

Paris Traffic Controlled by Wireless

DURING the visit of Their Majesties to France the gendarmerie of Paris made use of a low cruising dirigible for the control of traffic, it being in wireless communication with a mobile ground station.

Brussels Broadcasting House

ALTHOUGH the new building has been completed it is not expected to be completely equipped for three months. The inauguration will probably take place next November.

That East Anglian Relay

THE decision to erect a 5-kW relay station in the Norwich district, or a little farther inland, is still trembling in the balance, but B.B.C. engineers have recently completed a survey with mobile receiving equipment to gauge the field strength of all the home broadcasting stations in Norfolk, Suffolk and parts of Nottinghamshire and Lincolnshire.

French Television Takes a Rest

TELEVISION transmissions from the Eiffel Tower closed down on July 15th for a month in order to make certain technical readjustments. This is a striking emulation of the fine B.B.C. example set last year when the London television station closed down for three weeks.

Pianoforte Electro-Acoustics

AT a recent meeting of the Institute of Wireless Technology the President, Mr. Sydney A. Hurren, gave an interesting lecture on Pianoforte Electro-Acoustics. He described the principles of the "Pianotron," in which each note has its own pick-up by which effective and permanent "voicing" can be secured over the whole range; a demonstration on the instrument followed.

New York Likes 16 Metres

AMERICAN theatre-goers are adjured by the *New York Times* to make a practice of tuning-in Daventry on 16 metres for recordings of programmes which they have missed during the evening.

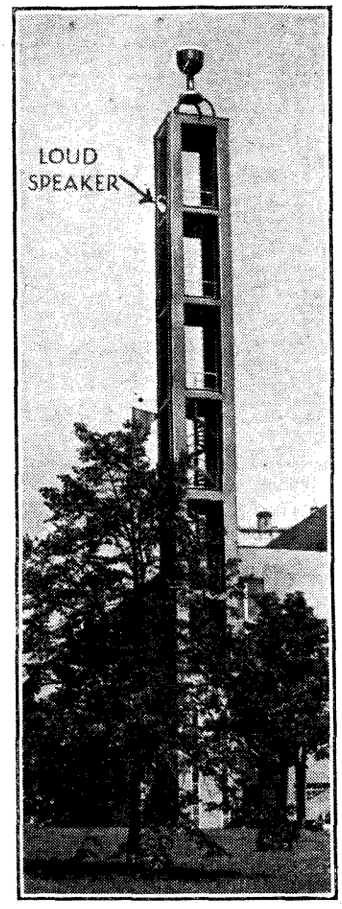
According to New York opinion, London leads the way in 16-metre broadcasting from Europe to America. During the early evening both GSG and GSP are reported to be giving clear, interference-free reception.

Dubilier Sports

THE fifteenth annual sports meeting of the Dubilier Athletic Sports Association was held on Saturday, July 16th.

Miscellaneous Advertisements for August 4th Issue

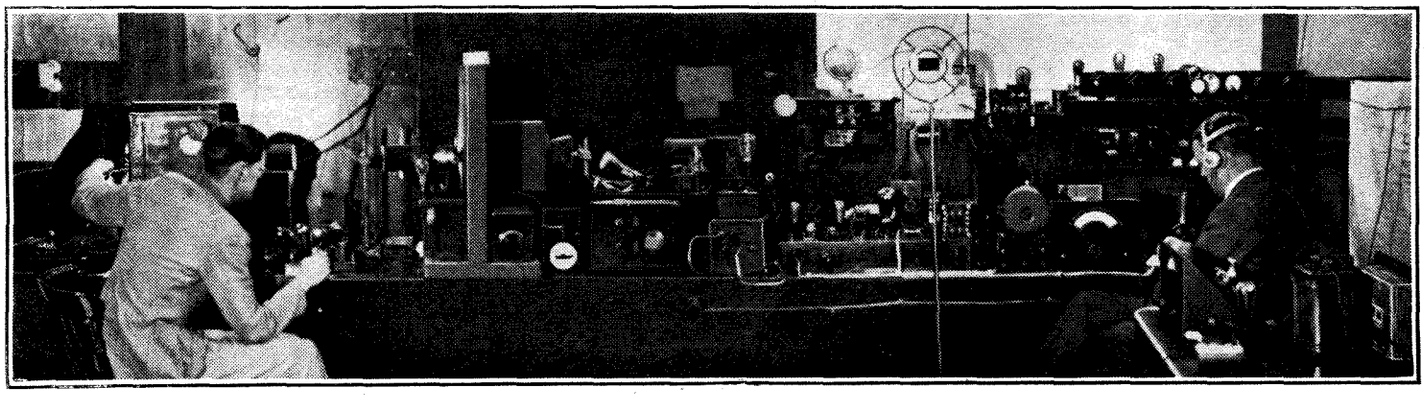
WITH the approach of the August Bank Holiday slight alterations are necessary in our printing arrangements. Miscellaneous advertisements intended for the issue of August 4th must be received not later than first post tomorrow, Friday, July 29th.



SPIRE OF A MODERN CHURCH in Prague, Czechoslovakia, which is probably the only one of its kind in the world to have been expressly designed for the accommodation of an electrical sound reproduction system; a loud speaker near the top of the spire diffuses peals of bells "rung" from a recording.

R.S.G.B. Convention

AN enterprising programme has been arranged for the 13th Convention of the Radio Society of Great Britain which will be held from September 1st to 3rd. The programme, besides including those hardy annuals the Saturday Night Dinner and I.E.E. Meetings, also embraces visits to Alexandra Palace, Greenwich Observatory, Broadcasting House and the G.E.C. Research Laboratories at Wembley.



EXPERIMENTAL TELEVISION transmissions radiated from station G6PU at Portsmouth Municipal College have been successfully conducted for some time. Mr. A. Parsons, Senior Lecturer in Telecommunications is seen (right) at the end of the lab. bench where photo-electric cell sub-amplifier, modulator and 25-watt 10-metre vision transmitter are located. On the left a student is operating the arc and low-definition scanning arrangements.

Developing a High-Quality Communication Receiver

How a Receiver is Designed—XX

THE TUNING SYSTEM

BEFORE proceeding to discuss the details of the RF stage and frequency-changer, it is necessary to consider the tuning system which we shall adopt. As pointed out in an earlier article our aim is to provide a tuning range of from, approximately 5 metres to 2,000 metres, the only gap in this band being around 645 metres which corresponds to the intermediate frequency of 465 kc/s. The obvious thing to do is to use a single variable condenser and a wavechange switch, as shown in Fig. 21, which enables a series of different coils to be used, thus dividing the enormous range into a number each of which is of more reasonable magnitude.

This, in fact, is the way in which most receivers cover the short, medium and long wavebands. Most receivers, however, do not tune below about 13 metres, and some do not even go to as low a waveband as this. It is then possible to use only one or two short wavebands in addition to the medium and long wavebands with small gaps in unimportant parts of the whole range. This course, however, is likely to involve us in difficulties if we try to extend the tuning range down to 5 metres and for two reasons. The first is that the total minimum capacity in the tuned circuit is likely to be so high that the coil inductance required for tuning to 5 metres will be of the same order as the inductance of the wiring. The other is that at the maximum capacity of a variable condenser of large enough capacity to give an adequate tuning range, the L/C ratio will be so low that a very poor performance will be secured. Experience shows that for ultra-short-wave reception the tuning condenser should not have a larger capacity than about 60 $\mu\mu$F. On the medium and long wavebands, however, the capacity should not be less than 350 $\mu\mu$F, if the whole of the medium-wave band is to be covered, and it is actually easier if a higher capacity is used.

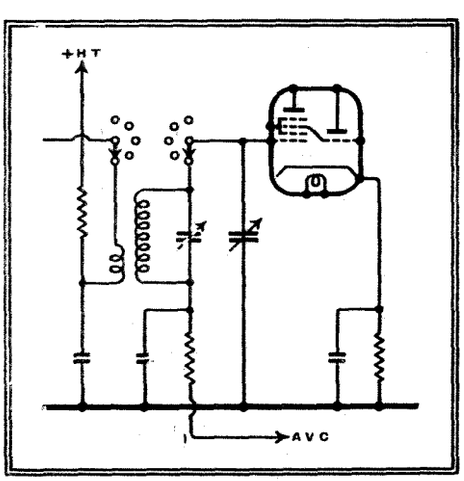


Fig. 21.—The conventional switching system with a single variable condenser is shown here.

It would seem, therefore, that the right course to adopt is to use two variable condensers, one of small capacity suitable for ultra-short wavelengths, and the other of large capacity suitable for the broadcast bands. Only in this way can we avoid an unsatisfactory compromise. It is obviously impossible to use only a small-capacity condenser, because the tuning range obtainable would be so small that we should probably need fifteen bands or more to cover the whole range of wavelengths. A single large condenser, however, while satisfactory from the point of view of giving a small number of bands, makes it extremely difficult to secure a satisfactory performance at ultra-short waves.

IN a receiver covering a wide range of wavelengths the tuning system is of great importance and the general alternatives are discussed in detail in this article. It is shown that the use of two variable condensers—one of large and the other of small capacity—is desirable.

The first thing to do is obviously to assess the values of the stray circuit capacities, for these govern the tuning range obtainable with a given variable condenser. We can estimate these capacities as follows:— The self-capacity of the coil is likely to be about 5 $\mu\mu$F, and we can allow 3 $\mu\mu$F for the switch and 7 $\mu\mu$F for the input capacity of the valve. Wiring will add a further 3 $\mu\mu$F, and the output capacity of the preceding valve can be taken roughly as 5 $\mu\mu$F, since we are likely to be using a step-up ratio in an inter-valve transformer. This gives a total of 25 $\mu\mu$F, to which we must add about 5.5 $\mu\mu$F for the extra capacity of the trimmer.

On the ultra-short-wave side, therefore, the minimum capacities are unlikely to be less than 30.5 $\mu\mu$F apart from the minimum capacity of the variable condenser itself. In the choice of the condenser we are limited by the components available, but it so happens that an eminently suitable model is now obtainable. It has widely spaced plates and ceramic insulation with a minimum capacity of 8 $\mu\mu$F and a maximum of 60 $\mu\mu$F. With a circuit minimum of 30.5 $\mu\mu$F this makes the total capacity variable between the limits of 38.5 $\mu\mu$F and 90.5 $\mu\mu$F giving a capacity ratio of 2.35 : 1 and a frequency or wavelength ratio of 1.535 : 1.

Choosing the inductance values so that the bands overlap slightly we can cover 5 – 16.65 metres in three bands of 5 – 7.7 metres (60 – 39 Mc/s), 7.5 – 11.5 metres (40 – 26.1 Mc/s) and 10.87 – 16.65 metres (27.6 – 18 Mc/s). The inductance values for these bands come out respectively as 0.1835 μH, 0.412 μH and 0.87 μH. When using two variable condensers in this way the most convenient switching system is that shown in Fig. 22. Here L1 C1 represent the ultra-short-wave coils and condenser controlled by the switch S1. In one position of the switch the ultra-short-wave coils are all disconnected and contact is made with the arm of the second switch S2, to which is connected the variable condenser C2 of large capacity. This switch selects the higher inductance coils for the longer wavelengths. On ultra-short-waves only the small condenser, C1, is in circuit, but on the other bands the small condenser is in parallel with the main one.

The Lower Frequency Ranges

For the present we shall assume that this will be set at medium when the larger condenser is being used and we shall now proceed to estimate the stray capacities of the circuits tuned by the larger capacity. This will be the same as before except that we have to add a further 3 $\mu\mu$F for the switch, another 5 $\mu\mu$F for wiring, and 8 $\mu\mu$F for the minimum capacity of the small variable condenser. In addition, we shall add a further 9 $\mu\mu$F to take care of the probably higher self-capacities of some of the longer wavelength coils and the possibly higher transferred valve capacities, since we may not want to use such a big step-down ratio in transformers. We shall, therefore, take the total minimum as 55 $\mu\mu$F for all ranges tuned by C2. A standard variable condenser of similar general construction to the small capacity one has a minimum capacity of 13.5 $\mu\mu$F and a maximum of 525 $\mu\mu$F, giving a capacity change of 68.5 $\mu\mu$F to 580 $\mu\mu$F.

High-Quality Communication Receiver—

This is a ratio of 8.46 – 1, giving a frequency or wavelength ratio of 2.91 to 1. On the long waveband we have to tune to 150 kc/s or 2,000 metres. To allow a little overlap, we shall make the lowest frequency 140 kc/s, and we can then cover 0.406 – 0.14 Mc/s (740 – 2,145 metres) for the long-wave band. For the medium-wave band we shall probably be wise if we set the lowest frequency as 0.5 Mc/s or 600 metres, even if we cannot quite reach 200 metres on this band. Taking this figure our lowest wavelength is 207.5 metres (1.455 Mc/s).

The next band will obviously overlap with this and must also obviously be tuned by the large condenser. We can, therefore, arbitrarily fix the lowest frequency as 1.2 Mc. and then the highest works out as 3.5 Mc/s (85.7 – 250 metres). We have now a gap of 18 – 3.5 Mc/s, and we have to decide whether we shall use the large condenser or the small for this gap or whether we shall adopt a compromise by using both, each for a portion of the range. Here practical considerations are likely to decide us because the usual switch plates have a maximum of 5 contacts. For the switch S1 we require one contact for the change-over to S2 which leaves four possible bands for this condenser. For the other we can have a maximum of five bands.

Now with two further bands using the large condenser we can fill in the gap completely allowing reasonable overlap. Using the small condenser only we should require four bands to fill in the gap which would make a total of seven bands for the small condenser, and we should need eight contacts on the switch. Apart from the difficulty of accommodating the extra coils and trimmers we should have to use a non-standard switch. We could, by using two extra ranges on the small condenser just overlap with one extra range on the large condenser making five small condenser ranges and four large. We should now require a six-contact switch for S1, however, and the overlap between ranges would be quite small and would allow little latitude for variations in circuit constants.

It will, therefore, probably be best to content ourselves with the three bands only for the small condenser and to fill in the gap by two bands on the large condenser. These work out at 2.75 – 8 Mc/s (109 – 37.5 metres) and 6.87 – 20 Mc/s (43.6 – 15 metres). With eight bands arranged in this way we can obtain a continuous tuning range from 60 – 0.14 Mc/s (5 – 2,145 metres), except for the gap of 0.5 – 0.406 Mc/s or 600 – 740 metres, which gap is necessary for the intermediate frequency. The inductance values for the five bands controlled by the large-capacity condenser work out at 0.927 μH, 5.8 μH, 30.25 μH, 175 μH and 2,250 μH respectively, taking the ranges in ascending order of wavelength.

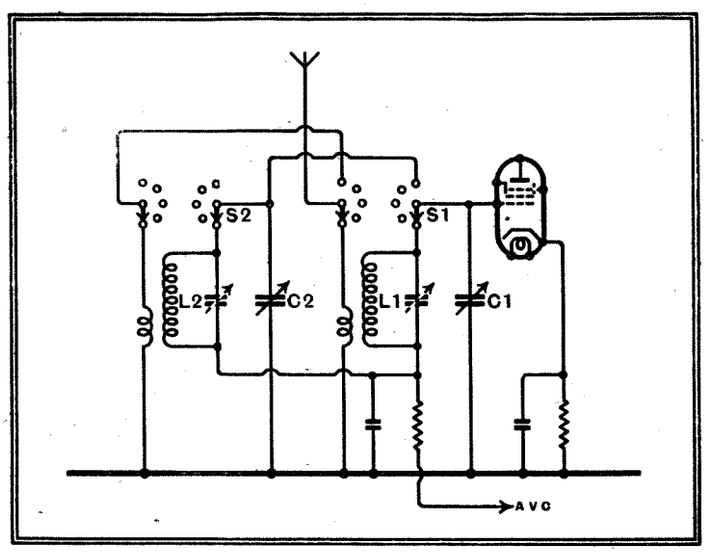


Fig. 22.—By adopting two waveband switches two variable condensers can be used without unduly complicating the wiring.

These values of inductance are suitable for the signal-frequency tuned circuits. The primary for the RF transformer and for the aerial coupling must be determined largely experimentally, and in the design of the coils themselves a compromise must be made between the conflicting requirements of efficiency and the available space. Actually, it will not be possible to use coils with a larger diameter than some 0.5in., because they will take up an unreasonable amount of space. Moreover, even if one could tolerate the space needed for large coils, when so many have to be accommodated the leads will become so long that on ultra-short waves the lead inductance would probably be as great as, if not greater than, the total inductance required by the tuned circuit.

In the oscillator circuit the coil inductances must be of lower value and a condenser must be inserted in series with the coil in order that the oscillator may function at a frequency higher than that of the signal by the intermediate frequency. When the signal-frequency circuit constants are known, formulæ exist for calculating the optimum values for the oscillator circuit inductance, parallel capacity and padding capacity. The parallel capacity must, of course, be adjustable, and on most bands the padding capacity must be adjustable also. On band 1 the padding capacity becomes infinite. Actually, of course, a finite value is required, but is so large that it can be ignored for practical purposes. On band 4 a definite value of capacity is required, but this is large and it is unnecessary to provide an adjustable trimmer. On all other bands, however, a portion of the capacity must be made adjustable to permit the exact value being chosen. This is all the more necessary since the capacity is used in practice to correct for very small variations in inductance which are inevitably present to some degree. The matching of the coils is naturally important, but this is beyond the ability of most constructors, since they have not suitable apparatus available. The main inductance matching, therefore, must be left to the coil manufacturer.

By adopting the arrangement shown with a small capacity condenser for the three ultra-short-wave ranges, we obtain good operating conditions, and, moreover, make tuning easier through keeping the frequency ratio at a reasonably low figure. On the other bands, a more normal frequency ratio is obtained, but this is not important because the small capacity condenser is then available to give band-spread.

TELEVISION PROGRAMMES

An hour's special film transmission intended for the industry only will be given from 11 a.m. to 12 noon each weekday.

THURSDAY, JULY 28th.

3, Jack Jackson and his Band. **3.35,** Gaumont-British News. **3.45,** Craftsmen at Work—Saddlery.

9, "Re-View," songs and scenes from bygone shows. **9.30,** British Movietonews. **9.40,** As at 3.45. **9.55,** Cartoon Film. **10,** Eric Wild and his Band. **10.20,** News Bulletin.

FRIDAY, JULY 29th.

3, Jane Carr. **3.10,** Film. **3.25-4,** "Nocturne in Palermo," by Clifford Bax, with music by A. Davies-Adams.

9, Starlight. **9.10,** Cartoon Film. **9.15,** Ballroom Dancing. **9.30,** Gaumont-British News. **9.40,** "Charivari"—variety. **10.10,** News Bulletin.

SATURDAY, JULY 30th.

3, In Our Garden, by Reginald Perry. **3.15,** Cartoon Film. **3.20,** "Re-View" (as on Thursday at 9 p.m.). **3.50,** Gaumont-British News.

9, "Order to View," a revue by Michael Trafford with music by Billy Milton. **9.30,** Film. **9.45,** "In the Dentist's Chair," the thriller by Anthony Armstrong. **10.5,** British Movietonews. **10.15,** News Bulletin.

SUNDAY, JULY 31st.

8.50, News Bulletin. **9.5-10.5,** "Bird in Hand," a play in three acts by John Drinkwater.

MONDAY, AUGUST 1st.

3, Cartoon Film. **3.5,** O.B. from the Crystal Palace of Bank Holiday Celebrations—"All the Fun of the Fair." **3.25,** Gaumont-British News. **3.35,** Crystal Palace O.B. continued. **3.50,** Film—Madrid in 1935.

9, Cabaret. **9.30,** British Movietonews. **9.40,** Cartoon Film. **9.50,** Catch-as-catch-can wrestling. **10.10,** News Bulletin.

TUESDAY, AUGUST 2nd.

3, Cabaret. **3.30,** British Movietonews. **3.40-4.10,** A panorama of Exhibitions, from Paris, 1797, to Glasgow, 1938.

9, Starlight—Jane Carr. **9.10,** Cartoon Film. **9.15,** "Ann and Harold," serial by Louis Goodrich, Episode 4—Their Wedding. **9.30,** Gaumont-British News. **9.40,** Pas Seul. **10,** News Bulletin.

WEDNESDAY, AUGUST 3rd.

3-4, "Bird in Hand" (as on Sunday at 9.5 p.m.).

9, Starlight. **9.10,** Cartoon Film. **9.15,** Tennis Demonstration. **9.30,** British Movietonews. **9.40,** "Contrasts." **10.10,** News Bulletin.

A Set Built on Professional Lines for Use by Amateurs

Hallicrafters SUPER

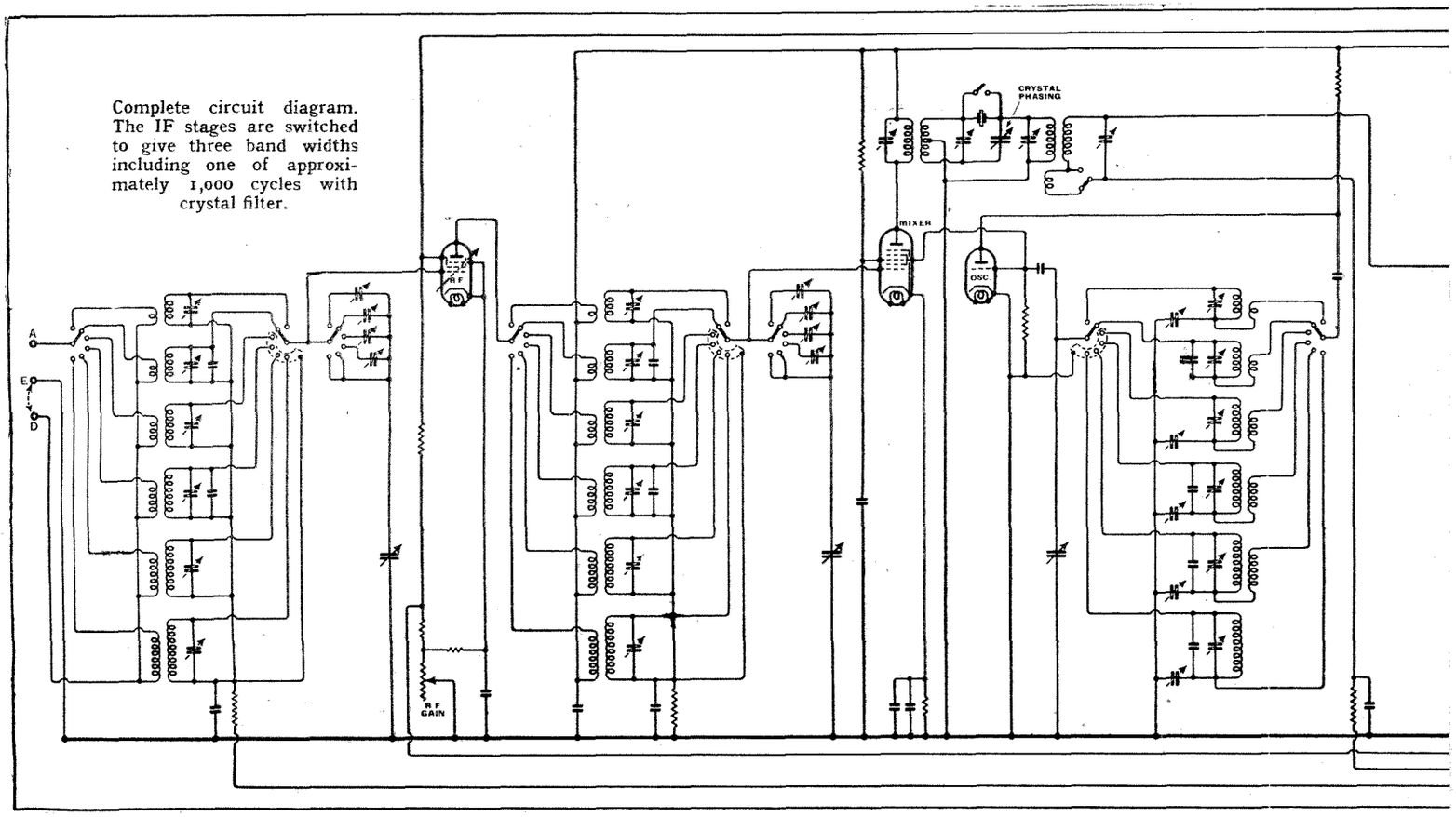
FEATURES. ***Waverange.***—*4.85 to 550 metres in six bands:—(1) 545-1555 kc/s. (2) 1545-4300 kc/s. (3) 4.2-10.2 Mc/s. (4) 9.8-20.5 Mc/s. (5) 19-36 Mc/s. (6) 35-62 Mc/s.* ***Circuit.***—*RF ampl.—mixer—separate osc.—1st IF ampl. and crystal filter—2nd IF ampl.—2nd det. AVC and 1st AF ampl.—push-pull output tetrodes. Beat freq. osc.—signal indicator ampl.—full-wave rectifier.* ***Controls.***—*(1) Main tuning. (2) Band spread tuning. (3) Waverange. (4) AF gain. (5) RF gain and signal meter switch. (6) BFO injector and on-off switch. (7) BFO pitch control. (8) Selectivity switch. (9) Crystal filter switch. (10) Crystal phasing. (11) AVC on-off switch. (12) Send-receive switch. (13) Tone control and on-off switch. (14) Meter amplifier zero adjustment.* ***Agents and Distributors.***—*Webb's Radio, 14, Soho Street, London, W.1.*

DESIGNED primarily to meet the requirements of the American radio relay organisation the thoroughbred "communication" short-wave receiver has been developed to a high degree of electrical and mechanical perfection. The receiver under review is an excellent example of a type which is finding favour not only with the transmitting fraternity in this country but also with those who take an interest in long-distance short-wave reception, whether from the amateur or the professional point of view.

There are eleven valves, including rectifier, and six stages are in the direct line of amplification between aerial and loud speaker. Two of these are devoted to IF amplification, and there is an RF amplifier which functions on all six wave-bands. The high overall magnification which this arrangement promises is fully realised, and even at the highest frequencies the settings of the AF and RF volume controls indicate that there is an ample reserve of power on any signal.

By judicious allocation of the total amplification between these two controls an outstandingly good signal-to-noise ratio was obtained. Two American broadcast transmissions which were completely engulfed by background noise in a good "all-wave" set came through quite clearly on the Hallicrafters receiver.

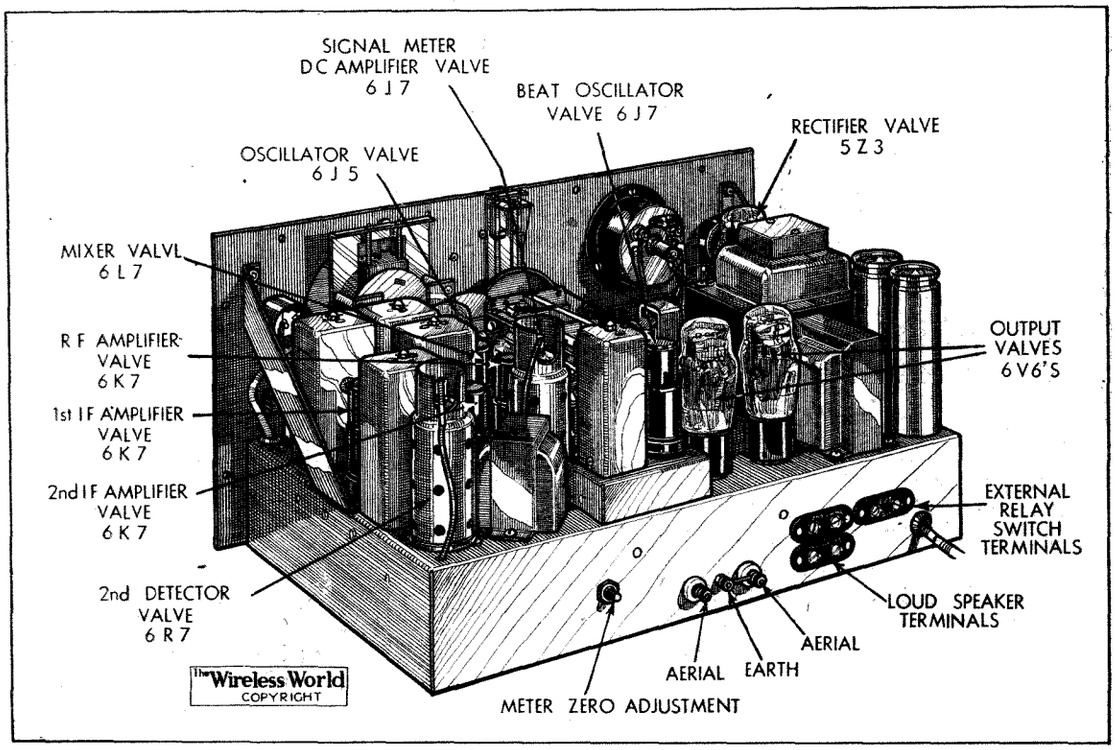
The set is also much more stable than most from the point of view of micro-



Complete circuit diagram. The IF stages are switched to give three band widths including one of approximately 1,000 cycles with crystal filter.

SKYRIDER

TYPE SX-16



In mechanical construction the chassis shows the same refinement in detail as is found in the circuit design. Ceramic insulation is widely used and will be seen in the aerial terminal supports.

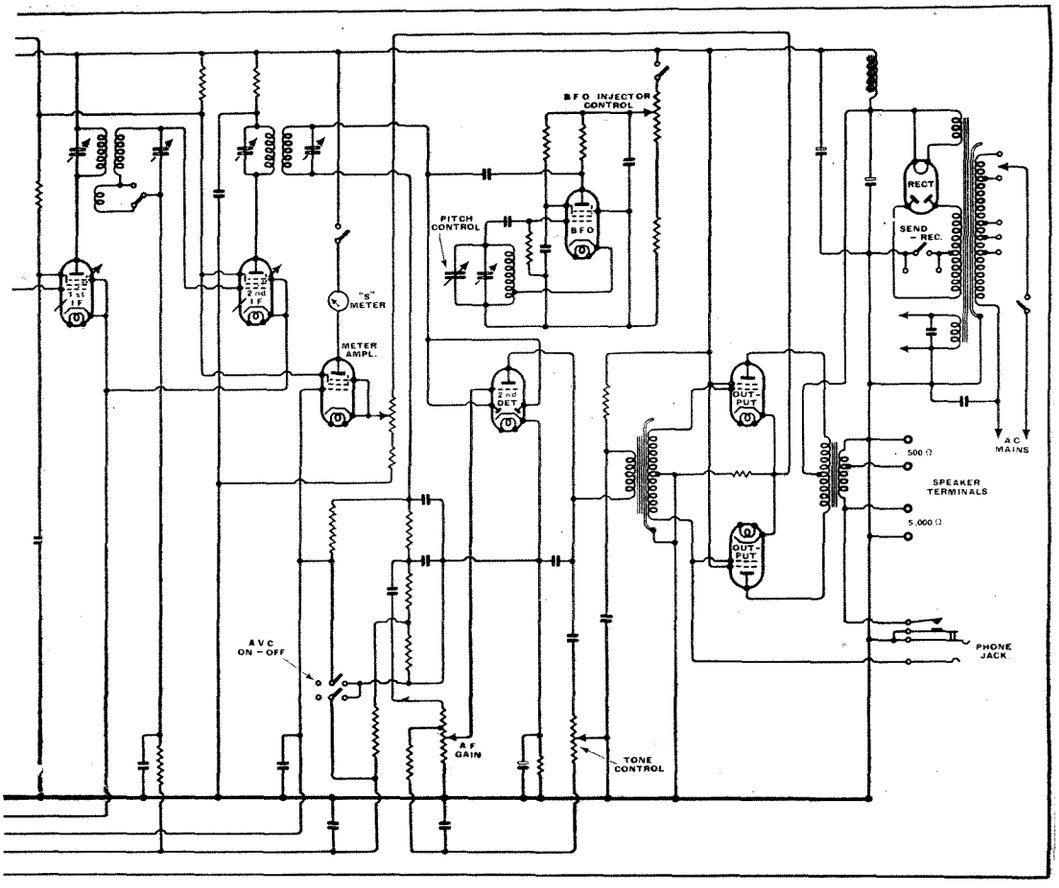
phony. Even on the television band with a carrier showing +9 (i.e., the maximum) on the signal strength meter far more watts than could be usefully employed were given by the output stage before the point of acoustic instability was reached. This is clearly marked, and there is no suggestion of feed-back building up gradually at any level below the threshold.

Frequency stability is of a high order, and the television sound carrier is as accurately tuned at the end as at the beginning of the hour's transmission. The frequency shift due to warming up is also much smaller than usual and well within the normal IF band width.

It is in the selectivity that this receiver shows its greatest superiority over broadcast sets. The normal operating band width of 7.5 kc/s for a 100: 1 reduction of signal strength can be narrowed to less than 1 kc by the crystal filter or expanded to 25.5 kc/s by switching in a third winding on the iron-cored IF transformers. With the broadened band width, quality of reproduction is first rate, and any lack of extreme top which a "high-fidelity" reproducer might reveal is more than compensated for by the clean handling of the middle and upper-middle registers by the push-pull output stage.

When the crystal is switched in and properly balanced it is possible to explore the modulation fringe of a broadcast transmission and get a very good estimate of the distribution of energy in different parts of the sound spectrum. When receiving CW signals with the beat oscillator in operation only one side of the zero beat comes through, so that selectivity may be visualised literally in terms of audio frequency. Incidentally, the strength of the local oscillation injected into the main circuit is under perfectly graduated control, and the pitch control is equally smooth in operation.

Every detail of the performance is neatly executed and well rounded off. Self-generated whistles are conspicuous by their absence, and only on the 32-62 Mc/s band is second channel breakthrough of any consequence. No set with one or even two RF stages could do better than this.



Smooth Controls

A good deal of attention has been given to what may be termed the amenities of working the set. To the seasoned experimenter this is important, for he may spend hours at the controls working to a prearranged schedule, and anything which will relieve the tension of constant application will be appreciated.

The main tuning condenser is of composite construction. Three of the stator vanes near the middle of each section are specially shaped to act also as stators for the small-capacity band-spread gang condenser with its own separate spindle and

Hallicrafters Super Skyrider—

rotors mounted at one side of the main condenser frame. By this arrangement, only one set of insulation for the combined stators is required and parallel losses are thus eliminated. Both the main and the band-spread tuning spindles are driven through reduction gearing incorporating lead flywheels to facilitate rapid movement from one part of the scale to another. The control knobs are of large diameter, and are moulded in bakelite with a smooth periphery. All these features combine to give just the right balance between the various demands of coarse and fine tuning.

The main tuning scale with its 338 degree scales is sufficiently accurate to locate a station within the range of the band-spread condenser. Each wave range is directly calibrated, and a pointer coupled with the wave-range switch automatically directs the eye to the appropriate scale. For accurate logging of stations, a vernier degree scale is provided on the outside edge of the metal dial.

The band-spread scale is engraved in the form of a spiral on a translucent scale with a shadow tuning device which leaves no ambiguity as to the portion of the scale to be read. There are no fewer than 1,000 degrees marked on this scale, and on the 20-metre band each degree is equivalent to a change of frequency of 5 kc/s. One complete turn of the band-spread control knob moves the scale five divisions.

The "S" meter is also provided with an internally illuminated scale. It is calibrated from zero to 9 plus, and is fed through a valve biased so that with no signal the maximum current is flowing in the meter. Any strong signal or atmospheric will result only in a reduction of current, and in order that the scale may be read in the conventional manner the meter has been given a right-hand zero. A potentiometer control for zero adjustment is fitted at the back of the chassis. Here will be found the terminals with ceramic insulation for doublet or single-wire aerials, and output terminals for loud speakers with 500 or 5,000 ohms impedance. The latter will be best suited to the majority of British speakers with transformers suitable for, say, a low-impedance triode valve.

Near the loud-speaker terminals is another terminal panel to which a remote control relay may be connected for breaking the HT supply when the transmitter is brought into operation. Actually these terminals are in parallel with the manually operated send-receive switch on the front panel. The headphone jack is connected to the triode portion of the second detector through half of the push-pull intervalve transformer. With this arrangement crystal headphones can be used without any special precautions.

This is a receiver which is exceptionally well turned out in every particular. It has the range and selectivity to satisfy the keenest long-distance enthusiast. It gives out signals cleanly without background noise, self-generated whistles or overload distortion, and it is rock stable in operation.

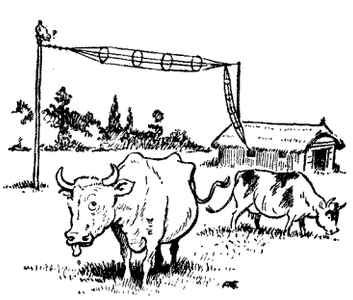
Unbiased

By FREE GRID

Relays and Autotuning

I SEEM to have raised a hornet's nest about my ears by the opinion I put forward in these columns recently that the motor-driven type of press-button receiver was the only one suitable for providing with a remote tuning control unit. You may recollect that my idea was to dodge the interference radiated by the house mains by placing a press-button receiver at the end of the garden out of harm's way and working it by means of a remote push-button unit.

Several readers have written to tell me that actually the type of push-button receiver in which each button puts a small pre-set fixed-variable condenser across each of the tuned circuits is equally applicable to remote control as is the motor-driven type; in fact, they tell me that it is actually simpler to arrange as all that has to be done is to use a simple solenoid to operate the push-buttons. If this be the case—and personally I cannot see any snags in it—I should think that an even simpler arrangement would be one of the so-called mechanical push-button sets where the button merely works a lever which shoves the tuning condenser round to a predetermined point. Surely a solenoid should be equally applicable to this also.



A receiver-house in the country.

At any rate, whether this is so or not, I can well see that the development of push-button sets has definitely solved the old controversy of relays versus individual wireless sets. All that need be done nowadays is for some enterprising company to build a gigantic receiver-house somewhere out in the country far from electrical interference and to invite everybody to house their receiver therein for a small weekly fee, tuning being done by remote push-button control.

Justice for Jazz-Lovers

I WAS very interested to read in a daily newspaper an article in which it was suggested that broadcasting wavelengths should be grouped together according to the type of entertainment that was to be sent out on them, one wavelength being reserved exclusively for high-brow stuff, another for talks and a third for jazz and broadcasts from the Zoological Gardens. The article containing the suggestions was written by one, Ivor Novello, who, judging from the exaggerated respect with which Mrs. Free Grid treated his name when I read it out from the newspaper at

"Exaggerated respect with which Mrs. Free Grid treated his name."

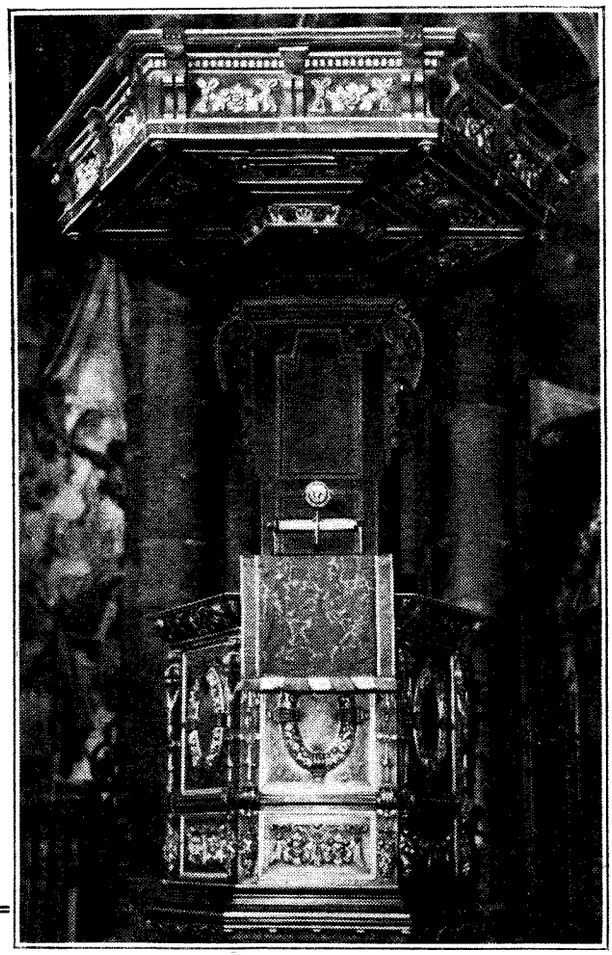
breakfast time, must, I think, be a film star or something like that. I am interested in the suggestion mainly because it has appeared so often in *The Wireless World*, both in my own weekly notes and in other less-widely-read parts of the journal.

Frankly, I cannot see that there would be the slightest difficulty in putting the idea into practice. Some people seem to anticipate that there would be a grave quarrel among the various groups as to which should have the best wavelengths. It is well known, of course, that down at the very bottom of the medium band there is less carrying power than higher up, and it might be thought that it would be very unfair to allot this particular part of the band to any type of programme, even chamber music, for instance.

I quite fail to agree with this as I see not the slightest reason why the promoters of low-brow jazz concerts should not be content to occupy this part of the wavelength spectrum. Although carrying power is admittedly restricted, this is more than compensated for by the fact that electrical interference, heterodyne whistles and sideband splutter are more prevalent. The presence of these extraneous noises cannot possibly be detected by the jazz-lover, since they merely sound like part of the programme; in fact, if anything, they improve it. There could then be no possible cause for complaint. In certain areas where interference is exceptionally bad it wouldn't much matter whether the ordinary jazz programme were heard or not as listeners wouldn't be able to detect its absence, as its similarity to man-made static is really extraordinary.

Sound Reinforcement in Westminster Abbey

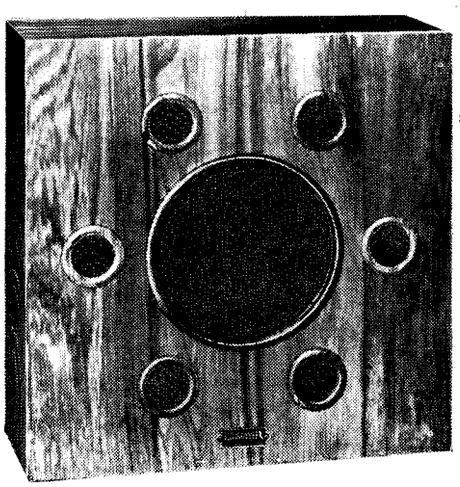
AN INSTALLATION PRESENTING UNUSUAL PROBLEMS



Mounting of the moving-coil microphone on the pulpit.

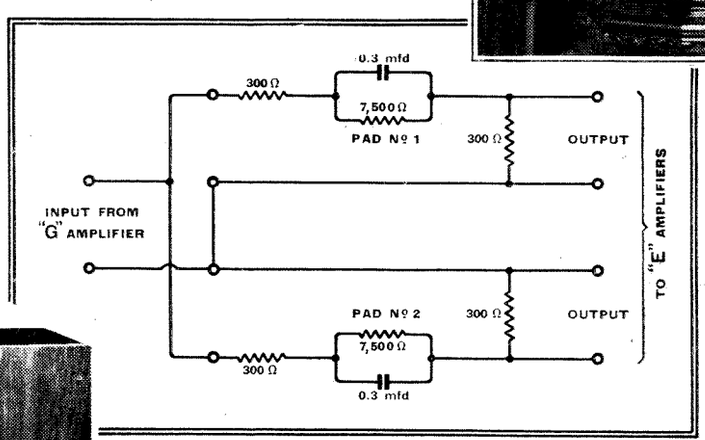
As may well be imagined, the installation of a permanent public address system in Westminster Abbey involved the solution of many problems arising from the acoustics and construction of the building. The extremely hard nature of the walls and floor spaces, together with the extreme height, made it necessary that a large number of loud speakers should be used but that all of them should be operated at a very low volume. The development of the "Brimavox" loud speaker by Standard Telephones and Cables, the firm responsible for the installation, greatly facilitated progress, and it is this instrument that serves throughout the Abbey. This loud speaker is of the permanent-magnet type, with dual diaphragms and a power rating of 2 watts. The speech coil impedance is 2.5 ohms, but a transformer is mounted on the chassis giving a standard impedance of 5,000 or 2,500 ohms. The former value was adopted throughout the installation.

In order to determine the most suitable volume at which the loud speakers should be operated and the area that could be satisfactorily covered by each, very many experiments were necessary. The final layout decided upon called for the installation of thirty-three loud speakers in all.



The Brimavox speaker ; radiation of low frequencies from the front of the diaphragm is reinforced in correct phase by radiation from the back through a series of tubes, the openings of which can be seen in this photograph.

It was found convenient to dispense with the cabinets and mount the units on $\frac{5}{8}$in. shaped baffle-boards in the Choir and High Altar positions. These baffles were then mounted inside the decorative canopies surmounting the choir stalls and sides of the Sanctuary, thereby screening them from view. It was not possible to hide the remaining cabinets, but they were subsequently painted to match their respective backgrounds. The average height of mounting the speakers throughout the whole installation was about 12ft.



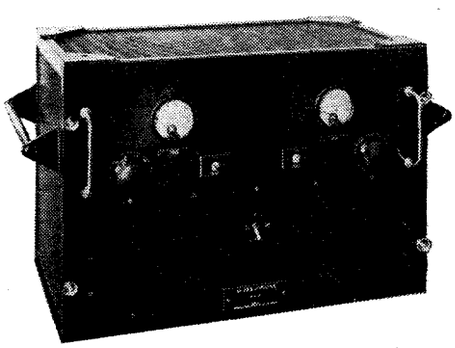
Correction network inserted between the input and output amplifiers.

To meet the requirements of the Abbey authorities, moving-coil microphones were installed, one being placed in the pulpit, lectern, precentor's desk and Sanctuary, and two at the High Altar, making a total of six in all. Three additional microphone points were wired but not equipped, one in the lantern and two in the nave.

Individual consideration was given to the method of mounting each microphone, and special fixings were made for each instrument with the exception of the microphone in the Sanctuary, which was mounted on a floorstand. This stand, in conjunction with an 80ft. screened cord and the additional microphone points already mentioned, afforded a considerable degree of flexibility for special services.

A single "G" amplifying unit was used to drive two "E" amplifiers, each delivering 30 watts. The nave circuit of fourteen speakers, considered to be approximately half the total load, was connected to one "E" amplifier. The second was used for the remaining circuits, which, excluding the monitor, totalled eighteen speakers. Each circuit was terminated on a control panel and matched by means of constant-impedance fader potentiometers to the 500-ohms output of the amplifier.

A separate on-off switch was included in each fader circuit, also a monitoring jack, thus enabling a flexible lead from the monitor speaker to be plugged into any desired output circuit. The micro-



One of the two Standard Telephones "E" amplifiers used to feed the loud speakers in the Abbey installation.

Sound Reinforcement in Westminster Abbey—phone keys are also incorporated in the control panel, and thus all microphones and speakers are controlled from the one panel.

In order to sharpen the speech and as an added precaution against any tendency to resonate, external pads, arranged as in the accompanying diagram, were connected between the output of the "G" and the inputs of the two "Es."

With regard to the operation of the equipment, it is essential that the controls should be continuously supervised during the entire service, thus ensuring that the speakers are worked at a suitable volume level and that appropriate microphones are selected. Certain Abbey vergers have been instructed in the operation of the equipment, and one of them is detailed for duty at the control panel during each service.

In America To-day

By Our Special Correspondent

SINGLE-ENDED TELEVISION PENTODES

IN several issues of *The Wireless World* there has been mentioned the possibility of shortening the wiring in a high-frequency amplifier by using alternate top-grid and top-plate pentodes. Another attack on this same problem is represented by the latest American television pentodes, which are known as types RCA-1852 and RCA-1853. These both have metal shells, eight-pin "octal" bases, and heaters drawing 450 milliamperes at 6.3 volts. They differ only in that the 1852 has a steeper slope and sharper cut-off. All leads come through the base, the argument being that it is more important to shorten the wiring than to keep grid and plate on opposite faces of the metal baseplate of the amplifier. There is room for opinion on that point, but it is quite true that the pin arrangement has been chosen to shorten the wiring while permitting the shield-can of the coupling device to serve the customary auxiliary purpose of screening each tube from its neighbour. The diagrams attempt to illustrate this and other points.

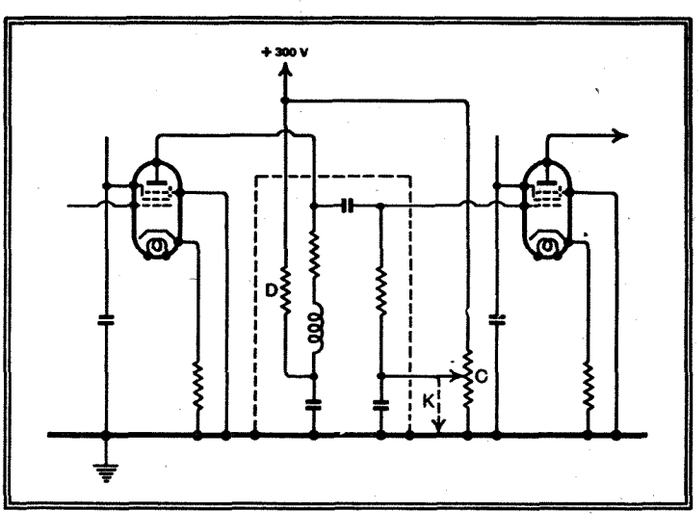


Fig. 1.—Resistance-coupled amplifier with sharp-cut-off tube type 1852.

In a resistance-coupled VF amplifier the sharp-cut-off 1852 is suitable, used somewhat as in Fig. 1. Two circuit conditions are here suggested. In the first the grid resistor has a value not greater than 250,000 ohms and is returned to chassis as indicated by the arrow K, the corresponding cathode resistor having a value of 160 ohms. The second condition applies to cases where it is necessary to employ a grid resistance as high as 1 megohm, with the consequent possibility of positive grid "locking." In this case the grid is first given a positive bias by returning the grid resistor as suggested by arrow C to a point about 9,000 ohms from the chassis end of a 259,000-ohm voltage divider whose "high" end is 300 volts (+) above chassis potential. This positive bias is then overbalanced by increasing the cathode resistor to 1,000 ohms. If for any reason the tube draws more than normal current, the overbalance increases and limits the rise. The screen supply (not shown) is through 60,000 ohms from a "plus 300" source. The heater has also been omitted for simplicity, two pins thus appearing blank. The plate circuit has been shown with the usual decoupler resistor D and a load composed of both inductance and resistance—say, 2,500 ohms of the latter—merely as an illustrative example. Cathode by-passing, if used, has the usual effect of increasing gain and distortion.

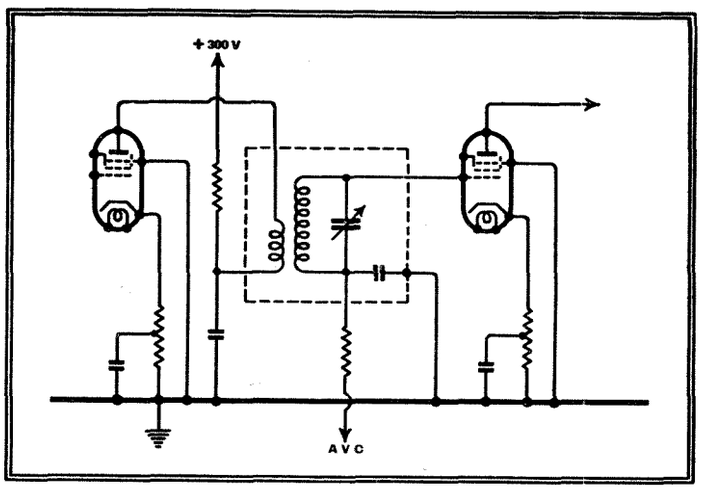


Fig. 2.—This diagram shows the arrangement for transformer coupling with either the sharp cut-off or remote cut-off tube.

Short wiring is also possible in a transformer-coupled stage, as shown by Fig. 2. In this case it is advisable to limit degeneration by partial by-passing of the cathode resistor. For the sharp-cut-off tube this resistor has a value of 160 ohms tapped for by-passing at 35 ohms from the cathode end, while for the remote-cut-off tube the values are 190 and 70 ohms respectively. The screen series resistor must be decreased from 60,000 to perhaps 30,000 ohms if the remote-cut-off tube is used.

The foregoing operating suggestions are in part, and the following constants altogether, supplied by the manufacturer, the Radio Corporation of America.

	1852	1853
Input capacitance (micro-micro-farads)	5	8
Output capacitance...	11	5
Feedback capacitance	.015	.015
Supply voltage ...	300	300
Screen series resistor	60,000	30,000
Cathode resistor ...	160 tapped or 160 or 1,000 plain (see text)	190 tapped (see text)
Amplification factor	6750	3500
Transconductance (mA/V) ...	9	5
Plate current (mA.)	10	12.5
Screen current (mA.)	2.5	3.2
Bias	*	— 3
Cut-off bias (approx.)	—12	—23

* Normally about —3, but actually adjusted to give normal plate current.

STANDARD-WAVE ANTENNA OF STATION KDKA

THE antenna used for medium-wave broadcasting from station KDKA, near Pittsburgh, Pennsylvania, U.S.A., is perhaps of only academic interest to a transatlantic reader, since it is designed for the particular purpose of preventing sky-wave transmission. The intent was, of course, not to prevent reception in Europe but to prevent the dreadful garbling of

In America To-day—

KDKA's signal in its normal service area—an effect only too well known in the Eastern United States.

The main antenna at KDKA is a vertical radiator with the customary buried radial net beneath it. Such an antenna provides a problem for the designer; by making it taller than is necessary for the best low-angle transmission into the normal service area he can at considerable cost secure a partial erasure of the high-angle or sky-wave transmission which causes garbling. Unfortunately, the erasure is not complete by any means. At KDKA the main antenna has therefore been made of a height to provide the best service-area signal and the sky-wave suppressed by a circle of auxiliary antennas. These auxiliaries are also vertical but of considerably lesser height. They are, in fact, somewhat less than ¼-wave high, but loaded to near-resonance. Exact resonance is avoided, since weather changes make it difficult to maintain resonance, as is all too well known to anyone who has ever worked with antenna arrays.

The main antenna has an adjustable top section and is set at something near ½-wave height (electrical height, that is). Power is fed to the main antenna only, the suppressor-antennas being parasitic. This arrangement not only provides a very simple feed-system but also makes possible the facile adjustment of phasing at the auxiliary antennas, by adjustment of the loading devices. Improvement of the signal at some points has certainly been very marked. It remains to be seen whether this improvement is sufficiently widespread to encourage the installation of similar systems at other stations. New England should be a notable proving ground for antenna systems, since the clear-signal service areas of some of our north-eastern stations resemble a slice of Swiss cheese. It is even reported that the very excellently operated 50 kilowatt station WTIC at Hartford, Connecticut, is very poorly heard at some points within 20 miles. The former 5 kilowatt WBZ, then located at Springfield, Massachusetts, and using an antenna power between 5 and 10 kilowatts, was very "fuzzy" at several points within plain eyesight of Springfield. Of course, KDKA is not in New England, but one automatically thinks of New England whenever there is talk of transmission improvement.

Change and Decay [*or Sour Grapes*]

1938 MODELS ARE NEARLY OUT OF DATE

ONE learns a lot from advertisements. On the principle of the survival of the fittest, those that fail to appeal presumably drop out, so what remains may be assumed to reflect human nature candidly—much more candidly than human nature itself would care to admit. Few people describe themselves as snobbish; yet the advertisements show that snob-appeal is a winning card.

Another winning card is novelty. Splashed across some advertisements one sees the single word "NEW"; few lack this word, which is nearly always underlined or printed in red. Or else we are told that the article offered is "Just Out!" Other announcements, while obviously reluctant to admit that last year's models left much to be desired, are full of the information that this year's are Improved, Much Improved, or even Enormously Improved. Offering the same model for a second year is equivalent to confessing failure. It doesn't matter how marvellous and perfect and in advance of its time it was the year before; in some mysterious way its virtue has departed from it merely with the passage of time.

Of course, the commercial motive is too obvious to need pointing out. But commerce would be unable to "cash in" on the novelty theme unless it were one of the fundamental human desires. In some fields it is not so. A person who tried to divert attention from Canterbury Cathedral by advertising a new and greatly improved cathedral in the same district would find little response. Connoisseurs of wine, too, are not impressed by the "Just Out!" type of publicity. But the radio-buying public are.

It is only to be expected, of course; because radio is a fast-developing affair.

By "CATHODE RAY"

If a set were to be brought out now of exactly the same type as those sold fifteen years ago, no amount of front-page shouting about its up-to-dateness would convince people that it really was an advance on last year's models.

Yet even a fifteen-year-old set might compare favourably in a few details with what is turned out now. I remember the loving care with which massive brass terminals were hand-lacquered and panel mounting screws were all turned with their slots exactly parallel to the edges. We should not let the advertisers bludgeon us into supposing that Change *always* means the same thing as Progress.

Quite a lot depends on the accident of which came first. If wireless had come first, then line telegraphy and telephony would have been hailed as a great advance, economising in power, simplifying processes, and ensuring secrecy of communication. If in some way, difficult to imagine, the triode had been invented after the pentode, might it not have displaced the pentode by reason of its obvious advantages—simplicity, cheapness, absence of screen current, purer amplification, freedom from risk of damage due to excessive load impedance, much greater latitude of load impedance? Change has unquestionably been a strong point in the valve industry during the last year or so; four of the best-known makers have now adopted different and non-interchangeable systems of bases. But if this is progress, show me the reversing lever.

Old, But Good

The earlier types of output transformer were terribly bulky and expensive. But at least their efficiency was over 50 per cent. and they did not saturate when the rated power was handled at low frequencies. If it only had the merit of being new, don't you think some firm would be glad to announce, as a great improvement, the idea of having the loud speaker separate from the receiver instead of being boxed up with it? And somebody would be floating a company to commercialise the clever new invention of miniature "loud" speakers (or *headphones*) to attach to individuals' ears so that they can listen without disturbing others. A counter-attraction might be an amazing new wireless wonder, a real sensation, a receiver needing *no* batteries, *no* mains, *no* power supply at all; *no* maintenance costs whatever! All this rendered possible by a marvellous crystal, more mysterious than any fortune-teller's! Can you imagine the demand? By the way, and getting back to reality, I believe crystal sets are still sold in small numbers, though nobody dares advertise them.

Perhaps, even, if all receivers hitherto had been of the push-button tuned type, somebody would be busy now laying out a national advertising campaign to herald the introduction at Radiolympia of a revolutionary new improvement in radio, something definitely years ahead—only a single knob for tuning to *all* stations! No unsightly rows of buttons; no retrimming; no motors; no ATC; no nothing, except pure undiluted enjoyment, with *one* key in your hand to *every* station!

When radio becomes old enough for the pioneers to become extinct, so that nobody remembers what the beginning was like, no doubt many things will come full circle. Already there have been examples. QPP was invented during the War, to make the best of valves then available. About seventeen years later the steady march of progress arrived at it again. It is like Einstein's theory that you have only to travel eastwards in space for long enough and you will arrive at the same place from the west.

The point of all this? Before we are very much older Radiolympia will be opening its doors (it is going to be a radio show this year, I hear) and 1938 models will be "out of date." Have you your money ready in your hand to exchange for all the NEW features of 1939? No? Well, perhaps I have been some consolation to you.

Random Radiations

By "DIALLIST"

The Spark Nuisance

SOME time ago I wrote optimistically that we should not have to endure spark interference on the medium-wave band much longer, as the days of the spark transmitter were numbered. A ship's radio operator is kind enough to send me "horse's mouth" information on the subject, which is not quite so cheering. It appears that under Article 7 of the Madrid Convention it is only the higher-powered spark transmitters that are to be banned the year after next. According to the Article mentioned, "No new installation for the emission of Type B waves may be fitted in ships or in aircraft, except when the transmitters, working on full power, take less than 300 watts at audible frequency measured at the input of the supply transformer." Actually, new ships are still being fitted with low-powered spark transmitters as their only means of radio communication, and unless some new agreement is concluded the spark nuisance may be with us indefinitely, though the intensity of the interference and the range at which it occurs may be considerably reduced. My correspondent, who should know what he is talking about, adds that the use of "spark" should be absolutely prohibited except for distress or similar signalling. I quite agree

Midget Televisors

I HEAR rumours that some of the television receivers using miniature cathode-ray tubes which will be on view at the Exhibition are to be marketed at prices which should bring them within range of a large number of possible viewers. It seems to be on the cards that the simplest and cheapest of these tiny television receivers may be for vision only. At first sight a receiver that doesn't deal with the accompanying sound might seem not very useful; but I am not so sure about that. Almost any small superhet without a high-frequency stage will receive the television sound within the area where the field strength is good, provided that it will tune down to a little above 14 metres, say between 21 and 22 megacycles. Reception takes place by means of the second harmonic of the oscillator—usually pretty strong—which beats with the sound fundamental frequency of 41.5 megacycles to produce the intermediate frequency of the receiver. I don't think I am giving away any trade secrets when I say that this oscillator second harmonic method of reception is actually made use of in some of the smaller sets which have a television sound range.

The Interference Height Limit

A WEEK or two ago I wrote in these notes that it was generally believed that, though the horizontal field of interference from car ignition systems could be extensive, it did not rise vertically much more than 30ft. above the source. A Lancashire reader, whom I have often heard at work on the amateur wavebands, writes to tell me about some experiences of his. His aerial, he tells me, is situated in a field bordering a main road which carries a good deal of traffic. Making a generous allowance for sag in the middle, the effective height of the aerial is at least 40ft. above the ignition system of any passing car. He has tried aerials of several different kinds, but his reception is so badly interfered with that a passing car will cause even a R9 signal to be swamped for a moment.

A Queer Effect

My correspondent does not mention whether or not the down-lead is screened. As the aerial is presumably quite near the road I should imagine that screening would be almost essential to prevent pick-up by the down-lead. Curiously enough, though, he has noticed that interference is at its worst not when a car is opposite the down-lead, but when it is on a level with the middle of the roof part of the aerial. And there's another interesting fact that has been observed. The road rises rather sharply as it passes the house. It is found that a car going uphill causes much more interference than one coming down, though the former is on the far side of the road. My correspondent suggests that this may be due to the fact that cars climbing the hill do so with a fully opened throttle, which means that a large volume of gas is drawn into the cylinders and that compression is high. He asks whether, in such circumstances, the magneto would not give a stronger spark. I should think it quite possible, for there is more resistance to be overcome.

Facts Wanted

I have read reports on a good many investigations into the extent of the interference field produced by car ignition systems, and to the best of my recollection all have been agreed that from 25 to 30ft. above the source is the limit of the height to which it extends. This Lancashire reader is inclined to class such estimates as bunkum and to believe that interference extends to at least 60ft., and probably higher than that, above the source. It would be interesting to know whether the experiences of other readers con-

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, JULY 28th.

Nat., 11.40 a.m., Launch of the new *Mauretania*. 6.40, Billy Cotton and his Band. 8, "Round the Fol-de-Rols," from the Isle of Wight, Llandudno and Hastings. 9, Louis Kentner, pianoforte.

Reg., 7, Suggestions for Week-End Walks in London. 8.40, "Dead Metaphors," talk by Lord Dunsany. 9, "Dear Love," a musical comedy.

Abroad.

Brussels II, 9, The I.N.R. Symphony Orchestra, conducted by Dejoncker, with Huybrechts, pianoforte.

FRIDAY, JULY 29th.

Nat., 7.40, "Paradise Isle"—variety. 8.15, Louis Levy Presents "You Shall Have Music." 9, "The Mighty Adam," musical play. 9.45, "Up Against It."

Reg., 8, "The Two *Mauretanias*," a sound picture of the two ships. 8.30, American Music relayed from Zurich. 9, Northern Music Hall. 10.25, "Ashore To-night": Dance Bands from the *Queen Mary* and the *Empress of Britain*.

Abroad.

Munich, 8.10, Bruckner's Seventh Symphony.

Paris, PTT, 8.30, Vichy Concert—The Municipal Symphony Orchestra, conducted by Fourestier, with Reynal, violin.

SATURDAY, JULY 30th.

Nat., 4.40 and 6.45, Navy Week at Portsmouth—commentaries from Portsmouth Dockyard. 7.30, Brian Lawrance and his Orchestra. 8, "The Case of the Frightened Lady" by Edgar Wallace. 10.25, Massed Bands of the Southern Command, from the Tidworth Tattoo.

Reg., 7.5, Amateur Photography—I, Talk by F. J. Mortimer, Editor of *Amateur Photographer*. 8.30, Sing-Song—a Saturday night entertainment.

Abroad.

Radio-Paris, 7, Salzburg Festival—"Fidelio," opera (Beethoven) from the Festival Theatre.

SUNDAY, JULY 31st.

Nat., 1.45, Troise and his Mandoliers. 6.30, Menges String Quartet. 9.5, Leslie Jeffries and his Orchestra.

Reg., 5, Medvedeff's Balalaika Orchestra. 9.5, "London on the Spree," Seven Centuries of Cockney Diversion. 9.45, Fred Hartley and his Sextet.

Abroad.

Radio-Paris, 8.15, Vichy Concert—"Rigoletto," opera (Verdi).

MONDAY, AUGUST 1st.

Nat., 7, "The Bungalow Club." 9, Victor Silvester and his Ballroom Orchestra. 9.45, "The Past Week," talk by the Hon. Harold Nicolson.

Reg., 8, Recital by Mark Hambourg. 8.20, Bank Holiday at Weston-super-Mare. 9, "To-day of All Days," comedy.

Abroad.

Frankfurt, 7 "Figaro," opera (Mozart).

Strasbourg, 8.30, "The Taming of the Shrew," comedy after Shakespeare.

TUESDAY, AUGUST 2nd.

Nat., 7.20, B.B.C. Theatre Organ and Three Grand Pianos. 8, Canadian Fantasy—from Toronto. 8.30, Seaside Nights: Southend.

Reg., 8, The Royal National Eisteddfod of Wales. Mass in B. Minor (Bach). 9.5, "The Absentee"—story by L. A. G. Strong. 9.30, "A Ship in the Bay," musical comedy.

Abroad.

Stuttgart, 8.15, Musical Conglomeration: Village Band, bass, guitar, piano, etc.

WEDNESDAY, AUGUST 3rd.

Nat., 6.25, Organ Recital by Maurice Vinden from the B.B.C. Concert Hall. 8, "A Ship in the Bay." 9, "The Mystery of the *Marie Celeste*."

Reg., 6, Irish Dance Music. 7, Variety. 8, Your Visit to Scotland. 9, Dave Frost and his Band.

Abroad.

Deutschlandsender, 7, "Don Giovanni," opera (Mozart).

Frankfurt, 8,15, "Song of the Danube," programme of folk music.

firm this view or not. Perhaps, too, some of the firms which specialise in the erection of anti-interference receiving aerials would tell us what height they find to be effective in getting rid of car ignition interference.

News from Schenectady

A VERY interesting letter about W2XAD and W2XAF, the Schenectady twins, comes from Mr. E. S. Darlington, who is in charge of short-wave broadcasting at the stations. He began his letter to me in momentary expectation of the arrival of a lorry to remove him, or rather his belongings, to the old WGY studios, which are being rebuilt for the short-wave stations' use. The lorry did actually arrive just as he was getting to the end of page 2, so he had to finish in haste and go. He tells me that the new 100-kilowatt plant, which will work on 9,550 kc/s (31.41 metres), is expected to be ready for its tests by September, if all goes well. I didn't know before that all of the transmitting gear made by the American G.E.C. is developed and tested at South Schenectady before being erected on its proper site. The 500-kilowatt WLW plant was made and tried out there before going to Cincinnati. The new 100-kilowatt short-wave plant will actually be allotted to W2XAD, for that station has now been assigned the additional frequency of 9,550 kilocycles. If it is found to work satisfactorily it may be the forerunner of other 100-kilowatt short-wave outfits in different parts of the United States.

Four Wavelengths Now

In the last paragraph I mentioned that an additional frequency had been assigned to W2XAD. This station is now using three frequencies. Here they are, with their times: 1 p.m. to 5 p.m. B.S.T., 21,500 kc/s (13.95 metres); South American beam transmission centred on Rio de Janeiro. 5.15 p.m. to 11 p.m., 15,300 kc/s (19.56 metres); beam transmission to Europe, centred on London. 12.15 a.m. to 4 a.m., 9,550 kc/s (31.41 metres); beam transmission for South America, centred on Rio. The sister station, W2XAF, works only on 9,530 kc/s (31.48 metres). From 9 p.m. to 11 p.m. B.S.T. it is using a horizontal dipole aerial, which is essentially non-directional. From 11 p.m. to 5 a.m. a South American beam transmission takes place, the beam being centred on Buenos Aires. The carrier power output of both stations is from 20 to 25 kilowatts, according to the frequency in use. On the beam transmissions the effective carrier power is reckoned as equivalent to between 200 and 250 kilowatts.

On the Short Waves

IN the first place, I must apologise to one or two readers for letters still unanswered. Unfortunately, through circumstances quite beyond my control, I have not been able to deal with any correspondence for some time now, but hope to be able to do so again shortly. Will those readers concerned please accept my apologies?

For the first time for many years my short-wave activities have been rather curtailed, so that these notes will necessarily be brief and deal mainly with the work of others.

My friend G5MA has again been active with his 5-metre portable station, and on July 10th visited his favourite site near Alton.

The following stations were contacted on two-way 'phone: G2GG Newbury—who, I believe, has been considerably heartened by these contacts after ploughing a rather lonely 5-metre furrow in that part of the world—G5CM Alsold, near Guildford, G8IX Woking, G3MR Berrylands, G8NV Golders Green (R7), G8MG Reading, G6XM Farnborough (on C.W.), G8LY, who represents the fairer sex at Winchester, and G5RD Abbots Langley and G5RD(P) at Coles Hill, near Amersham.

The last contact produced some interesting results, since G5RD's portable's signal rose from R4 on the "wrong side" of the hill to G5MA(P) to R9 when the transmitter was moved over to the "right side" of the hill.

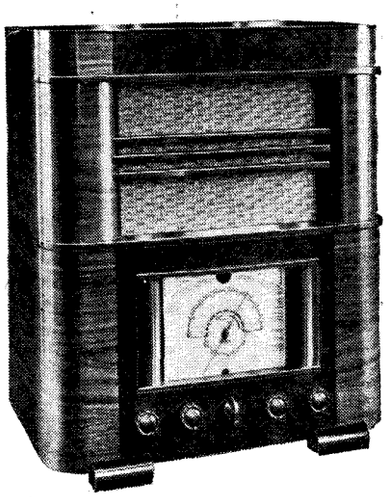
The power supply for G5MA's transmitter, that is the 300-volt HT supply, is derived from a car engine via a belt-driven generator, but how G5MA managed to get all the "works" under the bonnet we may never know; all I can say is it looks beautiful—an opinion, I believe, which G2OGD and others can confirm. ETHACOMBER.

"C. AND R. BRIDGE"

SOME readers have expressed doubt about using the bridge described in the issue of June 16th ("Home Laboratory" series) for measurement of electrolytic condensers, although these are specifically mentioned in the article. Their difficulty is the absence of provision for polarising voltage.

To relieve any uncertainty it can be stated that the bridge is quite suitable for measuring electrolytics as it stands, and no external polarising voltage is needed. Numerous tests have confirmed that such measurements agree satisfactorily with those obtained in more orthodox ways. The explanation appears to be that the condenser acts as a rectifier, and provided that (as in this case) there is no conducting path for the charge to leak off, it supplies its own polarising voltage.

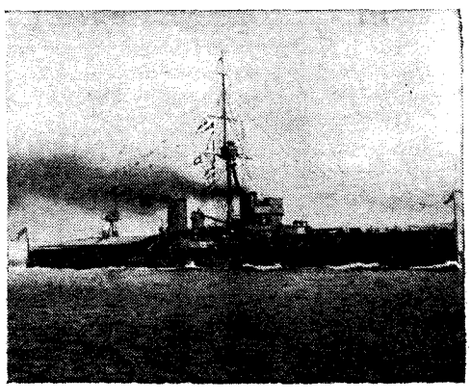
VIDOR MODEL 300



This four-waveband AC superheterodyne just released by Vidor Ltd. covers 13.5 to 2,000 metres and has a nine-valve circuit, including rectifier. The output stage makes use of two beam tetrodes and is rated at 18 watts. A separate control is provided to increase the bass response and the moving-coil loud speaker has a 10-inch diaphragm. The price is 13 guineas.

H.M. THE KING LAUNCHES WORLD'S GREATEST BATTLESHIP

H.M.S. DREADNOUGHT TAKES TO THE WATER AT PORTSMOUTH



..that was in 1906!

Big things happened in 1906. H.M. King Edward VII launched the then most formidable battleship the world had ever seen—Dreadnought—the forerunner of all heavily-armed fighting ships. Little things happened, too—some of them destined, with the years, to grow big in power and prestige. T.C.C., for instance. Founded in 1906 to make condensers, T.C.C. have been busy *making condensers* —nothing else—ever since. T.C.C. were making efficient, dependable condensers 32 years ago. They are still making them. Little—unknown—in 1906, today the name T.C.C. is known and respected wherever condensers are used.

T.C.C.
ALL-BRITISH
CONDENSERS

THE TELEGRAPH CONDENSER CO. LTD.
WALES FARM RD. NORTH ACTON. W.3

5282

Recent Inventions

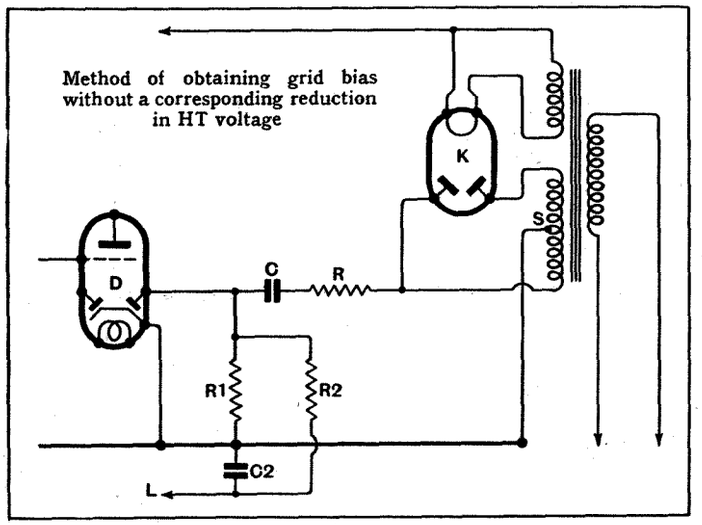
The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

"FREE" BIAS

IN a mains-driven receiver it is the practice to provide for grid-biasing voltages which are negative with respect to what may be called the "zero" or negative pole of the high-tension supply. Usually, however, this results in some reduction of the full voltage which would otherwise be available for the power stage of the set.

According to the invention, this limitation is avoided by inserting a separate rectifier in parallel with the AC supply, for developing a "free" voltage which is more negative than the normal zero. As shown in the figure, the additional rectifier consists of a diode D forming part of the electrode system of one of the valve amplifiers. The diode is connected through a blocking condenser C and limiting resistance R to one terminal of the secondary winding S of the usual mains-supply unit K, whilst the cathode is connected to a mid-point tapping on the same secondary winding. During each half-cycle of the supply, a negative voltage is built up across the load resistance R1, and is fed through a smoothing circuit R2, C2 to the grid-bias line L.



Method of obtaining grid bias without a corresponding reduction in HT voltage

J. E. Rhys-Jones, J. O. G. Barrett, and The Plessey Co., Ltd. Application date December 3rd, 1936. No. 484013.

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SHORT-WAVE VALVES

IN a valve of the Barkhausen-Kurz type, for handling very short waves, the anode is made of a series of wires which act as so many dipole aerials, and either radiate energy directly from the valve, or receive it. The dipoles are spaced apart by a fraction of the wave-length so as to have a directional effect. Preferably they are arranged in the form of a miniature aerial array of the so-called "fir-tree" type, which gives a pronounced beam effect.

The cathode of the valve is made of comparatively large area, though only the outer edges are coated with emissive material. One or more secondary-emission electrodes may be used to increase the supply of electrons.

Telefunken Ges fur drahtlose Telegraphie m.b.h. Convention date (Germany), May 6th, 1936. No. 483888.

A.V.C. IN TELEVISION

IN transmitting television signals it is necessary to vary the "mean" value of the carrier wave so that it shall keep step with slow changes in the "average" background illumination of the picture. This renders it difficult to apply the same methods of automatic volume control that are commonly used in broadcasting, where the carrier wave is "anchored" to a datum line, and where fading makes itself felt as a falling-off in the amplitude of the carrier about that line.

The invention is concerned with means for applying automatic volume control to television signals of the kind in which the carrier wave is varied from time to time as the average background illumination of the picture alters. The method consists in "displacing" the synchronising signals so that the minimum amplitude of the received signals corresponds with minimum picture modulation, and using this value as the basis from which AVC voltages are developed to offset the effect of fading.

H. E. Kallmann and R. E. Spencer. Application date, September 30th, 1936. No. 484202.

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CONTROLLING THE ELECTRON STREAM

IT is usual, both in receiving and transmitting valves, as well as in cathode-ray tubes, to place the main control grid, or control field, at a point where the velocity of the electron stream is comparatively low, so that the electrons remain under control for some appreciable time. In some cases, in fact, it is usual to insert retarding electrodes so as to reduce the electron velocity almost to zero at the point of control. This, of course, allows a comparatively low control voltage to be used.

But, on the other hand, if the time taken for the electrons to pass through the control field is comparable with the frequency of the applied signals, then the electron stream will absorb energy from the tuned input circuit, and will reduce the selectivity of the latter by damping.

According to the invention the electrons leaving the cathode are either sharply focused (or are otherwise forced by the shape of the electrodes) to travel in an oblique path, and the point of control is located at the far end of this path where the electron velocity is high.

Telefunken Ges fur drahtlose Telegraphie m.b.h. Convention date (Germany), October 8th, 1935. No. 483050.

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IN the so-called "beam" type of valve, the electrons emitted from the cathode are focused into a jet by a control grid and apertured anode, in much the same way as the "gun" forms the stream in a cathode-ray tube. The output electrode is spaced well away from the cathode, and the operation of the valve depends upon varying the number or intensity of the electrons, which are allowed to pass through. Usually the formation of the jet is effected by one set of electrodes, namely a control-grid, an apertured accelerator anode, and an apertured suppressor electrode, which is arranged close to and parallel with the anode.

It is found that with this arrangement the jet tends to spread too much laterally. The invention accordingly consists of inserting a second set of electrodes, similar to the first accelerator and suppressor discs, between the latter and the output or collecting plate. This allows a smaller control voltage to be used, and so increases the efficiency or mutual conductance of the valve.

Marconi's Wireless Telegraph Co., Ltd., and G. F. Brett. Application date October 26th, 1936. No. 483827.

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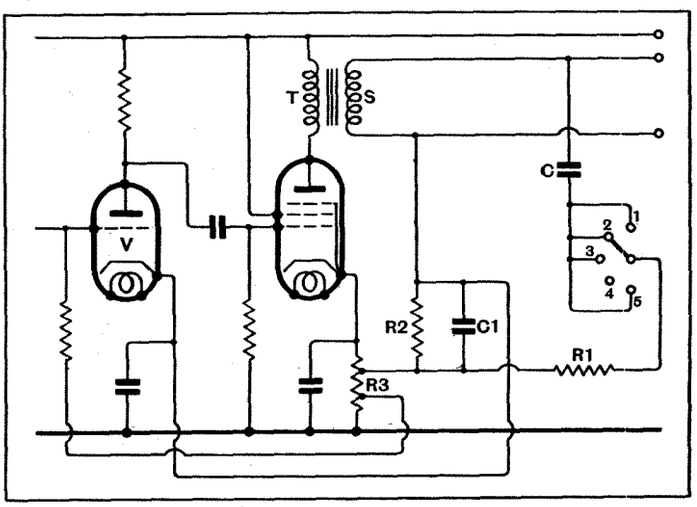
ALL-WAVE RECEIVERS

IT is known that better quality can be obtained by applying negative feed-back to the AF stage, particularly on a "universal" mains-driven set where there is a minimum HT supply. At the same time, the use of negative feed-back reduces the overall amplification of the set, and this is not always desirable, particularly on the short waves where sensitivity is important.

The object of the invention is to take advantage of both conditions by using negative feed-back on the long and middle waves, where quality is an important factor, and cutting it out for short-wave reception where the question of sensitivity or range comes first.

The drawing shows the AF stage of an all-wave set. The output transformer T is coupled to a special secondary winding S, which feeds two series resistances R1, R2 through a condenser C. The resistance R2 is included in the cathode lead of the valve V, and tapped to the biasing resistance R3. This applies negative feed-back, which is automatically "toned down" for the higher frequencies by the condenser C1.

A switch with five points 1 - - - 5 which is ganged with the wave-change switch, open-circuits the "feed-back" connection on the short-wave setting 4, leaving it operative for the first three wave-settings, as well as for gramophone reproduction on the last contact —point 5.



Negative feed-back circuit for all-wave set arranged to be inoperative on the short waves.

G. Priechenfried. Application date January 25th, 1937. No. 483869.